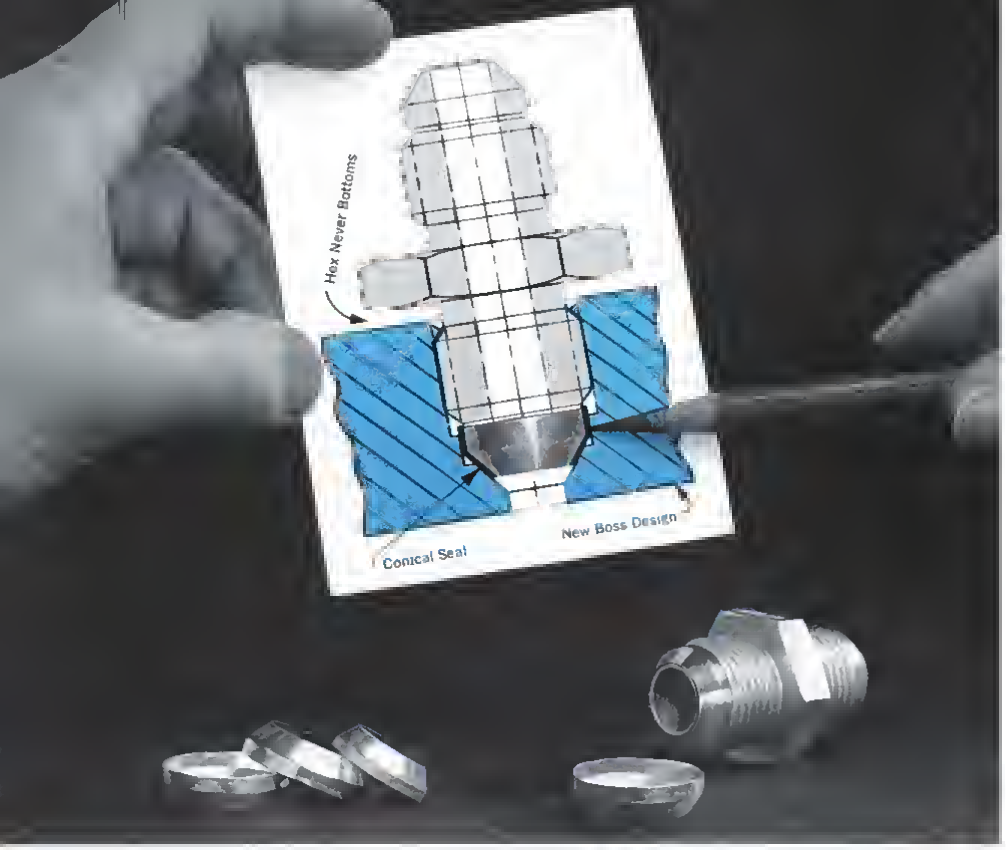
75 Cents

MARCH 12, 1962

Aviation Week and Space Technology

A McGRAW-HILL PUBLICATION

29th Inventory of Aerospace Power



Voi-Shan's "Fitting" Solution to Sealing Problems

ANOTHER FIRST: Voi Shan's latest fitting design is a superior replacement for the present AN0 10050 Boss design that eliminates the present use of the rubber 'O" ring by incorporating the Conical Seal Into the Boss This is accomplished by a shorter controlled depth due to the removal of the "O' ring, while still allowing use with the standard AN fittings Advantages of this new design are:

1. Increase of the temperature spectrum from the −40°F to +400°F range to −420°F to +1500°F renge
2. Extended valve life, Due to greater resistance to temperatures in Cryogenic and Radiation applications

THE CONICAL SEAL* employed in this design is a soft malleable crush washer specifically for use on the conical sealing surface of AN type flared fittings Imperfections of the conical surfaces and variations in concentricity are corrected by the use of the seal It is available in a wide variety of sizes and materials

Voi Shan also offers the Scott Connector System, which is a lightweight small envelope replacement for present flared and flareless fittings

The conical seal is a further example of Voi Shan's engineering superiority in the precision fastener and fittings industry Write for detailed information and catalogs on this and other Voi Shan products.

*Manufactured under license from General Dynamics Corp.

VOI-SHAN MANUFACTURING COMPANY
8463 Higuera Street, Culver City, California

LAND, SEA, AIR OR SPACE...TALENT THAT BUILDS BETTER DEFENSE SYSTEMS

Are you wasting time and money on *specialized* electronic check-out equipment for every new weapons system or subsystem? Goodyear's Central Programmed and Evaluator can save costs and reduce lead-time

Available now, the CPE costs many thousands of dollars less than other equipment in its field It can perform 4,000 tests with one program tape Typical DC accuracy is ± 0 05% of actual value measured (not full scale) in the 1-600 volt range Time, frequency, resistance, phase angle and AC voltage are also measured with a similar high degree of accuracy. Capabilities include fault-isolation of equipment under test, self-verification, and self-fault isolation through modular construction

This concept in electronic test and check-out equipment is typical of Goodyear Aircraft Corporation's capabilities in land, sea, air or space defense systems.

If *now* is when we can be of service to you in advanced systems and technology ... aerospace support equipment ... electronic subsystems ... lightweight structures or missile requirements, write Goodyear Aircraft Corporation, Akron 15, Ohio, or Litchfield Park, Arizona

PROMISING CAREERS FOR EXPERIENCED ENGINEERS INTERESTED IN ELECTRONICS

GOODYEAR

GOODYEAR AIRCRAFT CORPORATION

See Goodyear Aircraft's CPE in operation at the IRE Show, Booth No 3123 New York Coliseum March 26-29, 1962

← Circle Number 2 on Reader Service Card

Circle Number 3 on Reader Service Card →

AVIATION WEEK and Space Technology

March 12 1962

Vol 76 No 11

PUBLISHER	Robert W Martin Jr
EDITOR	Robert B Hotz
MANAGING EDITOR	William Gregory
TECHNICAL EDITOR	David A Anderton
EUROPEAN EDITOR	Cecil Brownlow
BUREAU CHIEFS	
WASHINGTON	Evert Clark
LOS ANGELES	Irving Stone
DALLAS	Erwin J Bulban
LONDON	Herbert J Coleman
DESK EDITORS	Harry Raven, Arnold Sherman, David A Brown, Richard G O'Lone
AVIONICS EDITOR	Philip J Klass
ASSISTANT	Barry Miller
TRANSPORT EDITOR	L L Doty
ASSISTANTS	Glenn Garrison, Robert H Cook, David H Hoffman, Ward Wright
ENGINEERING	Russell Hawkes, William S Reed
SPACE TECHNOLOGY	Edward H Kolcum, George Alexander
MILITARY EDITOR	Larry Booda
BUSINESS FLYING	Erwin J Bulban, Andrew A. Kell
CONGRESS	George C Wilson, Katherine Johnsen
EQUIPMENT	James D Hendricks
ART EDITOR	Lawrence J Herb
EDITORIAL PRODUCTION	Frank Miazga
ASSISTANT EDITORS	Edith Walford, Ann Dunphy
EDITORIAL ASSISTANTS	Marjorie Todd, Madge Hammond
LIBRARIAN	Therese V Maggio

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. Executive Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: [illegible] President [illegible] OFFICERS OF THE CORPORATION: [illegible] Vice President and Secretary.

Available only by paid subscription. Publisher reserves the right to refuse non-qualified subscriptions. Subscriptions to Aviation Week solicited only from persons who have a commercial or professional interest in aviation [illegible] orders forwarded to address shown in box below.

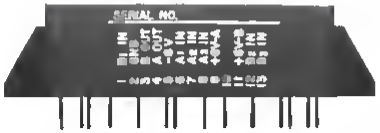
Single copies [illegible] Subscription rates [illegible]

[illegible]

Second class postage at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office. Copyright 1962 by McGraw-Hill Publishing Co., Inc. All rights reserved. Cable Address: McGraw-Hill New York. Publications combined with AVIATION WEEK and SPACE TECHNOLOGY are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

Subscribers: Send correspondence and change of address to Fulfillment Manager, Aviation Week, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, including postal zone number. [illegible] one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, Aviation Week and Space Technology, 330 West 42nd Street, New York 36, N. Y.



In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

These **SILICON** modules come epoxy encapsulated, and operate over a temperature range of −55°C to +100°C. And these same reliable **DIGITAL** circuits are available packaged on plug-in circuit cards. These Delco **MODULES** are environmentally proved to: **SHOCK,** 1,000G's in all planes. **VIBRATION,** 15G's at 10 to 2,000 cps. **HUMIDITY,** 95% at max. temp. **STORAGE AND STERILIZATION TEMP.** −65°C to +125°C. **ACCELERATION,** 20G's. Designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Data sheets are available. Just write or call our Military Sales Department.

Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

Division of General Motors • Kokomo, Indiana

DELCO RADIO

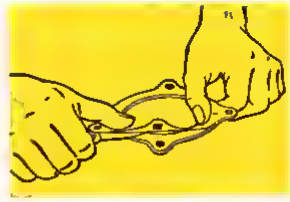
P-e-e-l-i-n-g Off to Flight Precision

It's a Shim made of LAMINUM® of course, meeting the close tolerances of sophisticated aircraft in a matter of seconds!

LAMINUM is the registered name for laminated shim stock that looks and acts like solid metal. Plastic bonded or metallic bonded, the laminations p-e-a-l off easily to give you a thousandth fit—right at the job.

No machining. No grinding. No counting. No stacking. No miking. And no costly stand-by equipment.

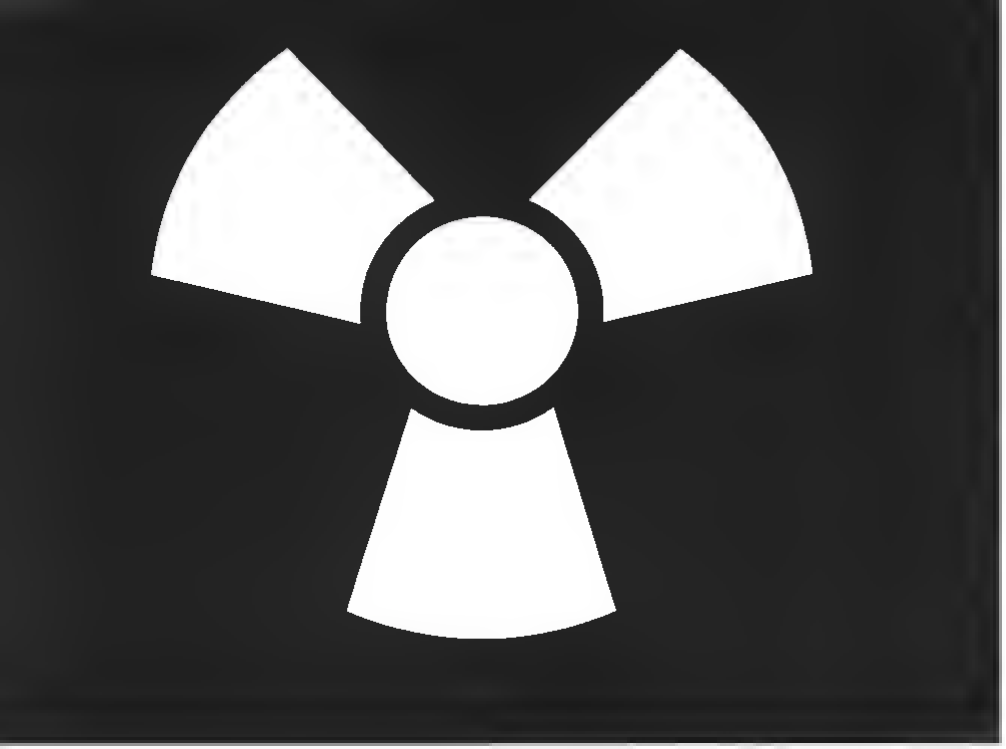
Shims of LAMINUM, custom-made to your own rigid specifications are quickly available from the oldest specialists in the country—serving aircraft and all metalworking since 1913! In Brass, Mild Steel, Type 302 Stainless and in Aluminum—with laminations of .002" or .003". **And now also in Titanium with laminations of .003"!** Any shape. Any size. Any quantity.



An inquiry will bring you the time-saving, cost-saving story of LAMINUM along with our recently published DESIGN FOLDER NO. 4 with complete up-to-the-minute engineering data. If you're in a burry—phone Templebar 6-1440 in Oakland, or Davis 5-2631 in Glenbrook.

THE LAMINATED SHIM COMPANY, INC.

Home Office and Plant: 5103 Union St., Glenbrook, Conn. • West Coast Sales and Service: 600 Sixteenth St., Oakland 12, Calif.



RADIOISOTOPES AND THE MILITARY VEHICLE

Strange companions? Not at Caterpillar.

These marvelous radioactive helpers enable Caterpillar Research engineers to establish the longevity expectations of vital components in a tiny fraction of the time consumed by conventional wear tests. After parts are bombarded with neutrons and made radioactive, they are subjected to maximum operational stresses and strains. Wear, no matter how slight, is precisely measured by the number of radioactive particles washed off in the lubricating oils.

Utilizing this advanced technique, Caterpillar engineers measure wear rates far more accurately in a brief 8 to 10-hour test than by conventional methods which require 500 to 1000 hours of continuous testing.

Sound, practical, imaginative engineering is standard procedure in Caterpillar's defense products effort: the development of new concepts in military vehicles, their components, and mobile or stationary military power packages.

Caterpillar engineers are currently engaged in practical and theoretical research in basic materials, metallurgy, fuels and lubricants, adhesives, ceramics, applied mechanics, fluid mechanics, soil dynamics, high-speed rotational phenomena and dozens of other fundamental programs.

They have primary responsibility in every stage of equipment development—in research, in design, in production engineering and quality control, and in the extensive field testing program at Caterpillar's 10,000 acre proving grounds facilities in Arizona and Illinois.

Each of the several hundred engineers at Caterpillar Research is backed by experienced staff members: designers . . . data analysts . . . instrument specialists . . . lab technicians . . . draftsmen . . . toolmakers . . . machinists . . . mechanics and equipment operators. Working with this skilled group are additional hundreds of engineers . . . designers . . . engine and vehicle specialists . . . each concentrating on developing better, more efficient machines, engines and equipment. This combined group of more than 2500 adds up to an able, experienced R & D team.

If you would like more information about Caterpillar's ability to arrive at practical solutions to problems in ground mobility or power units for the military, write Defense Products Department, Caterpillar Tractor Co., Peoria, Illinois.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Caterpillar Tractor Co., General Offices: Peoria, Illinois • Caterpillar Americas Co., Peoria, Illinois • Caterpillar Overseas S.A., Geneva • Caterpillar of Australia Pty. Ltd., Melbourne • Caterpillar Brasil S.A., São Paulo • Caterpillar Tractor Co. Ltd., Glasgow • Caterpillar of Canada Ltd., Toronto • Caterpillar France S.A., Grenoble

Circle Number 8 on Reader Service Card

"Delivery room" for a guidance system

Guidance systems and components for some of this country's most advanced ballistic missiles are being born in this room—and no hospital delivery room was ever kept freer from dust and dirt.

It's the "ultra-clean room" at Sperry Farragut—the cleanest of more than 6000 square feet of temperature-controlled clean-room facilities here. Its air locks and dust filters remove from the air all particles larger than 0.3 micron (12 millionths of an inch) and would stop cold the 3-5 micron bacteria dreaded in hospitals. Final assembly of guidance units for the MERCURY and SATURN missiles is carried out here—as well as assembly of a variety of other complex, precision mechanical and electro-mechanical equipment.

This clean room, probably the most advanced in the country in design and construction, is just one example of the ultra-modern facilities for precision military production at Sperry Farragut's 175,000 square-foot Bristol, Tennessee plant. These facilities are manned by a staff with outstanding technical competence and backed by the virtually unlimited capabilities of the Sperry Rand organization.

Our liaison engineers will welcome an opportunity to discuss application of Sperry Farragut facilities and capabilities to your requirements.

Capabilities and facilities for study, design, evaluation, prototype construction, and final quantity production of precision systems, subsystems, and components for:

- *Missile guidance and control*
- *Fire control*
- *Aircraft instrumentation*
- *Navigation—land, air and sea*
- *Computers*
- *Trail marking equipment*

SPERRY FARRAGUT COMPANY

DIVISION OF SPERRY RAND CORPORATION
BRISTOL, TENNESSEE

Circle Number 9 on Reader-Service Card

Jet Propulsion Laboratory will use Recomp III for processing data from NASA deep space tracking antennas

Think fast.

All computers think fast. But some think faster than others.

The Recomp® computer can save 1760 hours over its nearest competitor on a given project.

This was proven in an actual feasibility study.

Recomp was designed for speed. It has many features that take the waiting out of your work.

Like built ins:

Built in floating point. Built in square root command. Built in index register. Built in conversion from decimal to binary.

We don't know of any compact computer that has a larger word length than Recomp. 40 binary digits per word. Keep that in mind for problems such as matrix conversion.

There is a Recomp to fit your needs (and budget). You can lease one from $1,495 (complete with no accessories required) to $4,500 a month. Recomp II is for medium scale users. Recomp III is perfect for small-scale needs.

Recomp's accessory line and software advantages are the most up-to-date in the computer industry. And an extensive programming library is available without charge.

There are a number of small and medium scale computers on the market today. Only a few are really outstanding. Recomp is one of them.* For the full Recomp story, write:

AUTONETICS Industrial Products
Department 23, 3400 E. 70th Street, Long Beach, California
Autonetics is a Division of North American Aviation.

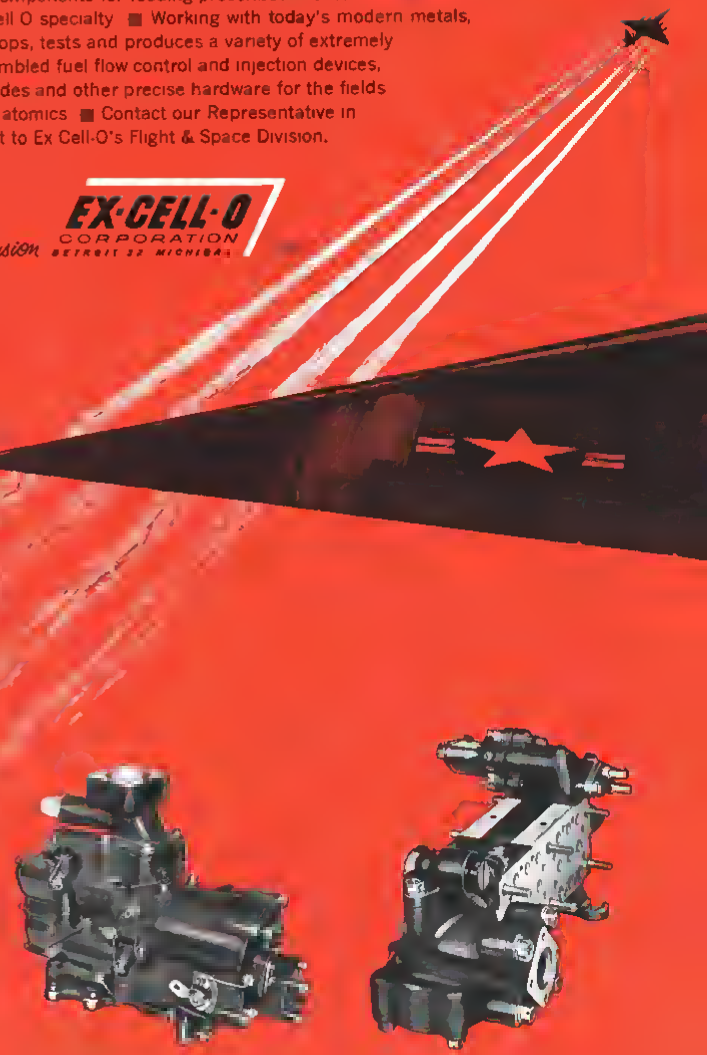
Recomp

*No computer feasibility study is complete without Recomp.

Rx for thirsty jets

Precision-machined, rigid-inspected fuel metering devices, nozzles, [illegible] bars and other critical components for feeding prescribed measures of fuel to thirsty jets are an Ex-Cell-O specialty. ■ Working with today's modern metals, Ex-Cell-O designs, develops, tests and produces a variety of extremely accurate, carefully assembled fuel flow control and injection devices, as well as actuators, blades and other precise hardware for the fields of aircraft, missiles and atomics. ■ Contact our Representative in your area, or write direct to Ex-Cell-O's Flight & Space Division.

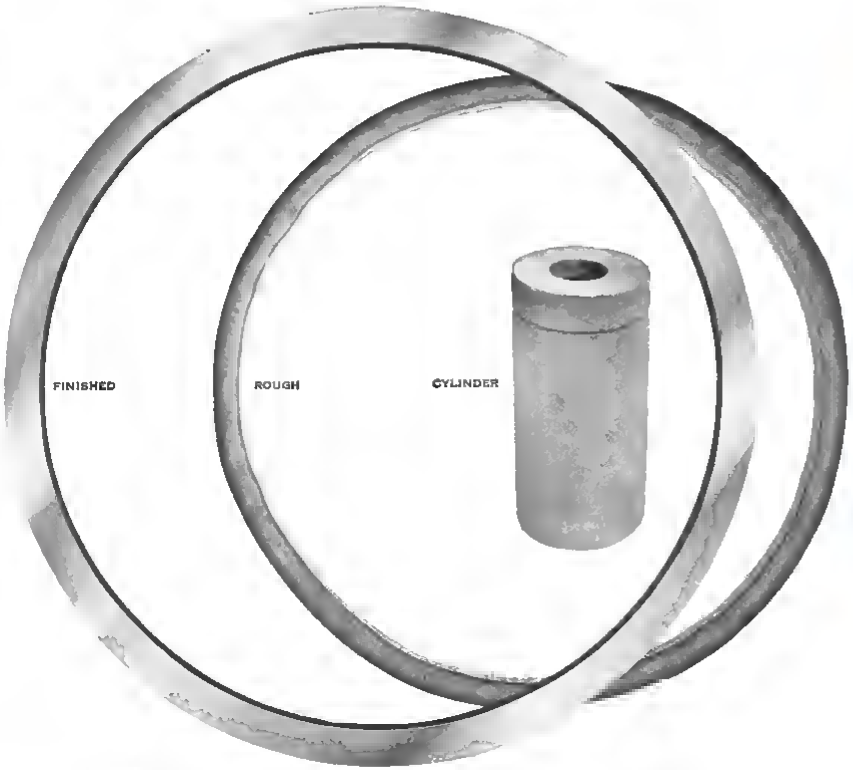
Flight & Space Division EX-CELL-O CORPORATION DETROIT 32, MICHIGAN



MAN AND MISSILES FLY HIGHER, FASTER AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O AND ITS SUBSIDIARIES BRYANT CHUCKING GRINDER CO., CADILLAC GAGE CO., MICHIGAN TOOL CO., SMITH BEARING CO. ■ EX-CELL-O FOR PRECISION. XLO

NOW—A WELD-FREE CM-R 41 RING

DEVELOPED BY C-M TO ELIMINATE THE PROBLEMS OF WELDED RINGS. THIS CM-R 41 RING IS FORGED FROM A CYLINDRICAL CASTING INSTEAD OF ROLLED FROM BAR STOCK AND WELDED. THIS INTEGRAL, WELD FREE CM-R 41 RING IS THE RESULT OF A CASTING PROCESS DEVELOPED BY C-M USING A THIN CROSS-SECTION RATHER THAN THE CONVENTIONAL THICK INGOT. BECAUSE THE CROSS-SECTION IS THINNER, IT COOLS QUICKER. THIS FAST COOLING PREVENTS SEGREGATION OF ELEMENTS—ELIMINATES STRINGERS. GRAIN SIZE IS MORE UNIFORM, TOO, AND THE RING HAS GREATER HOMOGENEITY THAN RINGS PRODUCED BY OTHER METHODS.



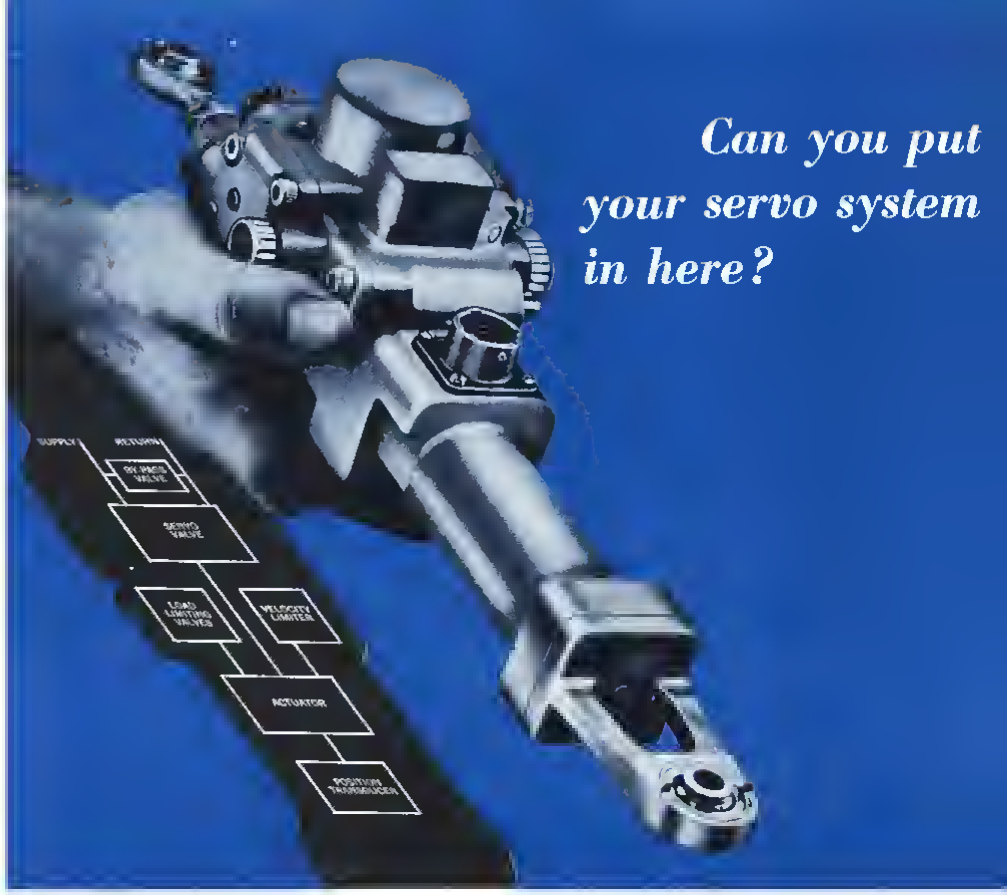
C-M'S PROCESS CAN HELP SOLVE YOUR RING PROBLEMS ON CM-R 41 AND OTHER DIFFICULT-TO-FORGE IRON, NICKEL AND COBALT ALLOYS. WRITE TODAY FOR COMPLETE INFORMATION.

ULTRAMET VACUUM ALLOYS

CANNON-MUSKEGON CORPORATION

METALLURGICAL SPECIALISTS • 2887 LINCOLN STREET • MUSKEGON, MICHIGAN

Circle Number 12 on Reader Service Card



Can you put your servo system in here?

This is a packaged servo actuator designed by Hydraulic Research for missile flight control. It is a completely integrated system with these advantages:

- increased reliability
- less contamination vulnerability
- lower production costs
- single vendor responsibility
- reduced weight
- improved compatibility of components
- simplified test and checkout

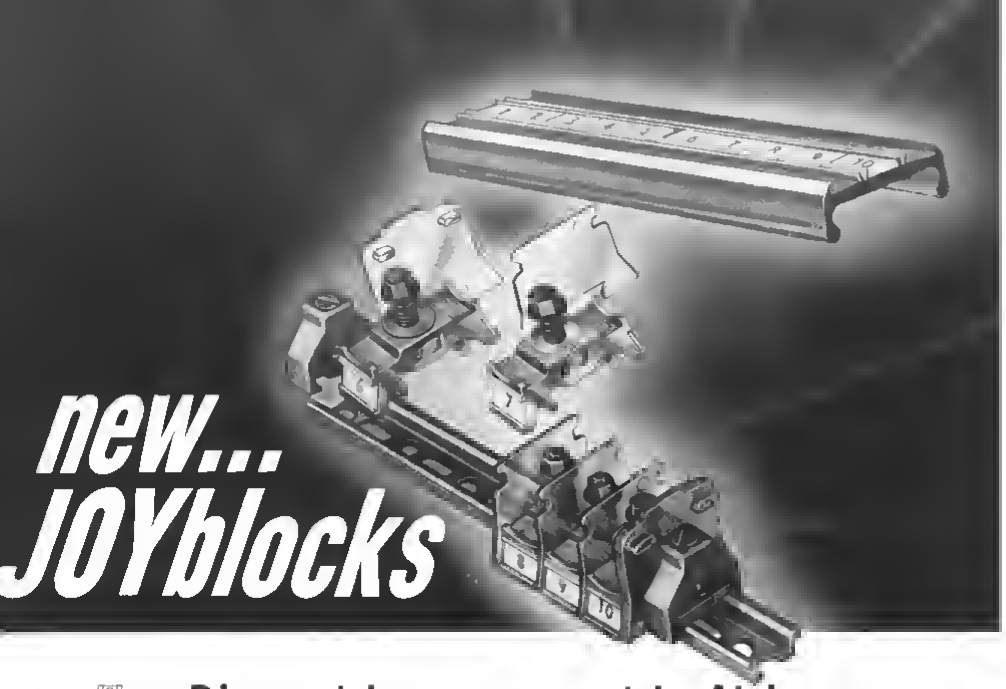
WHAT ABOUT YOUR FLIGHT CONTROL SYSTEM?

Hydraulic Research has designed, developed and produced complete integrated systems for dozens of different applications. Use this specialized experience and proven engineering skill on **your** project. Write for information, or call for consultation.

HYDRAULIC RESEARCH and Manufacturing Company

2835 N. Naomi Street, Burbank, California
Phone Victoria 9-6111
Division of Bell Aerospace Corporation

Circle Number 13 on Reader Service Card



Biggest Improvement in Airborne Terminal Blocks in Twenty Years!

Modular design permits replacement or addition of individual circuits without disturbance to others

Maintenance is simplicity itself. Individual terminal bases snap on and off the supporting rail. All you need is a screwdriver and a few seconds' time

Compact, lightweight. Save 75% in space, 55% in weight, compared with ordinary Military Standard terminal strips

Add more circuits quickly and easily. Merely loosen and extend end retainers and snap desired number of additional terminal bases onto rail

Rugged, durable JOYBLOCKS have withstood a whole battery of punishing environmental tests

"Biggest improvement in 20 years" is a verbatim quote from a veteran engineer in the aircraft and missile industry recently introduced to JOYBLOCKS. Here is one of those rare new products which truly deserve the description, "revolutionary." A French patented invention, JOYBLOCKS have been redesigned in American materials to American standards

JOY ELECTRICAL PRODUCTS DIVISION

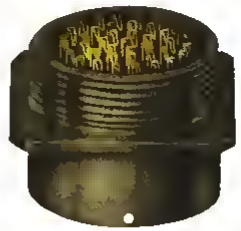
We'll be happy to send you a complete data package about new JOYBLOCKS. Write today

Room 457, Henry W. Oliver Bldg.
Pittsburgh 22, Pa.

CD-363-1

Circle Number 14 on Reader Service Card

BURNDY
MAKES ALL TYPES OF ELECTRICAL
CONNECTORS



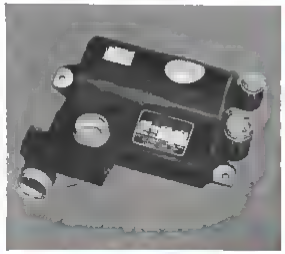
Solder BANTAM® miniature round connectors conform to MIL-C-26482A • mate with, or replace connectors conforming to spec • other insert configurations available • quick disconnect bayonet type plugs, receptacles vibration resistant, moisture proof within required temperature range • corrosion protection for contacts assured by extra heavy gold plating • other platings available • exclusive wire-seal grommet seals all wire types

solder or crimp

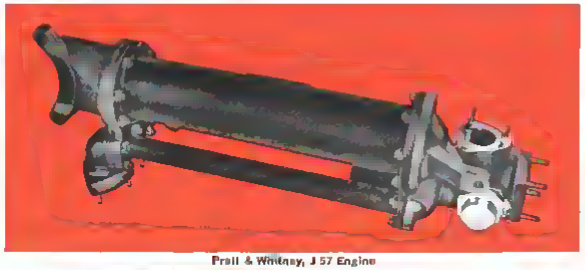
HYFEN® BANTAM mates with, replaces connectors conforming to MIL-C-26482 in controlled environment • other configurations accommodate combinations of standard and/or miniature coax • features crimp-type, removable contacts which reduce cost by permitting replacement of individual contact • socket contacts feature closed entry design • complete line of full cycling installation tooling facilitates quality control.

Write for catalogs—**BURNDY**, Norwalk, Connect.

Circle Number 15 on Reader-Service Card

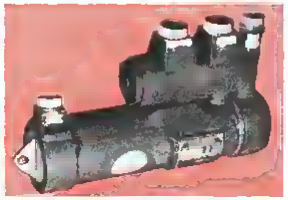


General Electric T-58 Engine

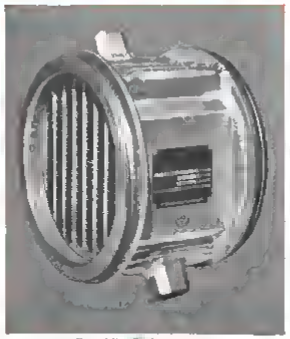


Pratt & Whitney, J 57 Engine

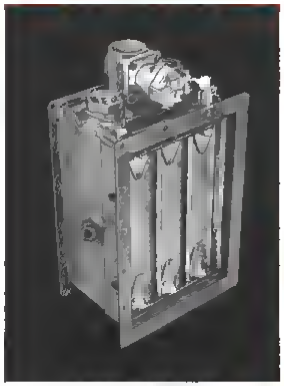
General Electric J 79 Engine



Lycoming, T55-L 5 Engine

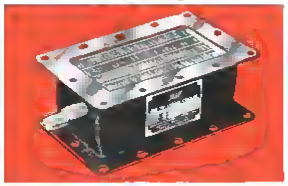


Republic, F-105 Aircraft



Canadair, CL 28 Aircraft

Allison, J 71 Engine



IBM B-52 Aircraft

Boeing, B-47 Aircraft

NOT FOR SALE

Not *these* models, anyway. They were custom-designed to customer specifications. And they're already performing cool miracles on reciprocating, gas turbine and jet engines, missiles and electronic equipment. However, UAP *will* design and build a heat exchanger to *your* exact requirements. Our qualifications? Been making aircraft heat exchangers since 1929. Rocked the industry when we introduced the Hi-D unit (one-third to one-fifth the size and weight of existing equipment). Have a customer list now that reads like "Who's Who in the Sky."

Very strong on military engine and missile applications where reliability is a pre-eminent requirement. Write or phone 224-3841 today. UAP means United Aircraft Products. *A dynamic, independent company in Dayton, Ohio. A name to remember when it comes to heat exchangers.*

Outstanding opportunities for qualified engineers.

UAP

THIS NEW VOLTMETER WAS DESIGNED BY 15,000 CUSTOMERS

You had a hand in the engineering of the FLUKE MODEL 825A DC DIFFERENTIAL VOLTMETER. Customer suggestions spanning seven years and 15,000 differential voltmeters have helped create the most versatile and reliable instrument of this type ever offered.

Beginning with an overall accuracy of ±0.025%, this advanced model features these significant advantages: recorder output — no zero controls — taut band meter suspension — flow soldered glass epoxy printed circuit boards.

To fully utilize the inherent advantages of high accuracy differentist voltage measurements, Fluke Model 825A provides two major features not found in other instruments.

1. *Infinite input impedance at null from 0 to plus or minus 500 VDC, this feature is extremely important since all voltages to be measured have significant source resistance. With the Model 825A operated at null, there will be no measurement errors due to circuit loading. The majority of other voltmeters provide a maximum of 10 megohms input impedance. Should the unknown voltage have a source resistance in the order of 5000 ohms, the measurement error due to source loading only will be at least 0.05% and does not include the basic error specification of the voltmeter itself.*

2. *Polarity reversing switch. A feature that enables you to measure either positive or negative voltages with equal ease. This is not merely a polarity reversal of front panel binding posts—but rather the internal 500 V reference supply is made either positive or negative with the front panel switch. This effectively provides you with two voltmeters for the price of one.*

PARTIAL 825A SPECIFICATIONS

OVERALL ACCURACY	±0.025%
MAXIMUM FULL SCALE NULL METER SENSITIVITY	1 MV
MAXIMUM NULL METER RESOLUTION	5 uv
STABILITY OF REFERENCE SUPPLY:	±0.005% per hour after warmup or ±0.005% for ±10% line voltage change
REFERENCE ELEMENT	Standard cell (zener diode optional)
INPUT VOLTAGE:	117/234 VAC ±10% from 50 to 400 cps

Write, wire or phone for short form catalog F-162

John Fluke Mfg. Company, Inc
Seattle 33, Wash
Box 7428 *PR 6-1171* *TWX—Halls Lake* *TLX—852*

FLUKE INSTRUMENTS

SEE THE ENTIRE LINE OF NEW FLUKE INSTRUMENTS/COMPONENTS * IRE SHOW BOOTH 3329-3231

Circle Number 17 on Reader-Service Card

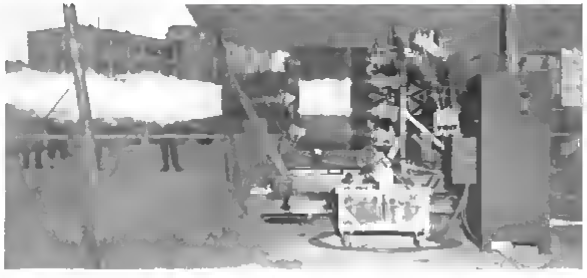
Flight Propulsion NEWS

A report about progress in research and products from the Flight Propulsion Division of the General Electric Company

First U.S. Turbojet Tested by G.E. Just 20 Years Ago

LYNN, MASS.—Twenty years ago here, under strictest secrecy, U.S. aviation witnessed an event that would send it headlong into the Jet Age. The time was March, 1942. The event: General Electric's initial testing of America's first turbojet engine.

The Nation's first jet engine, primitive by today's standards, was a centrifugal-flow powerplant that weighed 780 pounds and developed 1250 pounds thrust. To build it, the Government selected General Electric on the basis of its historic experience in the technology of compressors, turbines, and superchargers.



THE FIRST—flame streaks from a modified I-A engine in this historic photo of an early G-E test run. The first jet produced 1250 pounds thrust, weighed 780 lbs.

Six Months to Build

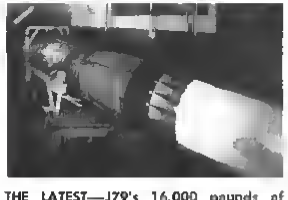
The G-E engine was based on the design of Great Britain's Whittle turbojet, drawings for which were received by the Company in October, 1941. Despite production and material hurdles that required numerous innovations, G.E. completed and test-fired its first engine in six months.

This was the I-A engine, forerunner of all American turbojets. In October of 1942 two I-A engines were installed aboard the Bell P-59A, built especially for the purpose and America's first jet aircraft took to the air.

By 1946 General Electric had successfully demonstrated the advantages of the axial-flow compressor for turbojet propulsion. Its first engine using this principle, the J35, was quickly followed by the historic J47, workhorse turbojet that today claims more actual combat hours in military aircraft than any other jet engine. The world-wide achievements of the J47-powered North American F-86 and Boeing B-47 over the past decade are now a matter of history.

G.E. Unveils J79

In 1955 G.E. unveiled the nation's first Mach 2 turbojet, the now-renowned J79, featuring a high thrust-to-weight ratio. The 16,000-pound thrust J79 began its extensive role in U.S. aviation by powering the Lockheed F-104, the Grumman F11F-1F and the Chance Vought Regulus II missile.



THE LATEST—J79's 16,000 pounds of thrust symbolize 20 years of propulsion progress. The J79, along with the smaller J85, are the latest of G.E.'s turbojets.

Today G.E.'s J79 turbojet, as production powerplant for the General Dynamics Corporation B-58, North American A3J, and McDonnell F4H, along with the F-104 Starfighter, has the distinction of having powered military aircraft to 24 international jet flight records.

After the debut of its J79 in 1958, G.E. was prepared for its entrance into the commercial jet aircraft industry. Its CJ-805-3 engine—civilian cousin of the J79—was chosen to power the Convair 880 transport, which went into service in May, 1960. As of January 1, 1962, it had accumulated more than 400,000 hours of flight time.

Small Engines Make Debut

In 1953 General Electric won a Navy competition to develop the 800 horsepower T58 turboshaft helicopter engine. The following year, under USAF contract, the company began development of the 2450-pound thrust J85 turbojet, versions of which have since grown to 3850 lbs thrust and over.

The T58 engine, currently rated at 1250 hp, powers the Sikorsky HSS-2, the Kaman HU2K, and the Boeing Vertol HRB-1. Its civil counterpart the CT58, first U.S. gas turbine to be FAA-certificated for commercial helicopters, is now in airline use on the Boeing Vertol 107, the Sikorsky S-61L, and S-62.

Meanwhile General Electric achieved a major advance in the state of the art in developing the high-thrust J85 engine, which was the beginning of a versatile family of military and commercial turbojets. Offering the highest thrust-to-weight ratio of any engine in the Free World today, the J85 is currently in high volume production as the powerplant for the supersonic T-38 and N-156 jets, the McDonnell GAM-72 decoy missile, Radioplane's Q-4B target drone, and NASA's X-14A VTOL demonstrator.

A Look Ahead

At the 20 year milepost of the Jet Age, General Electric's Flight Propulsion Division has behind it a production record of more than 35,000 engines whose operational record is currently nearing the 35 million flight-hour mark. Looking ahead, G.E. sees these as some of the highlights of its participation in the Jet Age's third decade:

- Additional V/STOL applications for its 2850 hp T64 turboshaft/turboprop, already undergoing flight test on the deHavilland Caribou DHC-4 and selected for the Vought Tri-service Transport.
- In 1963, the Nation's first flight test of a fan-in-wing aircraft, powered for VTOL by G.E.'s J85-driven X353 lift fan.
- Growth of experience in Mach 3 propulsion, to be gained from the North American B-70's G.E.-built J93 engines, plus basic supersonic transport propulsion research.
- Expansion of its role in the business jet aircraft market, where the G-E JE5/CJ610 turbojet has already been chosen to power Swiss-American's SAAC-23, the Aero Commander Jet 1121, and the Piaggio-Douglas PD-808.
- Continuing turbofan engine progress with such successful advanced powerplants as the CJ-805-23 (powering the Convair 990 and the Caravelle 10A), and the aft-fan version of the CJ610, the G-E CF700.
- Projection of turbojet technology and experience into propulsion systems for the Aerospace Age, including ion, arc jet, and rocket engines, and air breathing boosters for space vehicles.

These and other developments at G.E.'s Cincinnati, Ohio, and Lynn, Mass., facilities are helping give the U.S. dramatic impetus as it enters the 21st year of the Jet Era.

POISED AT FULL THROTTLE, this United States Navy McDonnell F4H "Phantom II" gets its launch signal from catapult officer during final phases of Carrier Suitability Trials aboard the FRANKLIN D. ROOSEVELT. During the 10-day trial period which ended last December 14, performance of the aircraft and engine was outstanding. Powered by two General Electric J79 turbojet engines, the F4H is destined to become the Navy's standard Mach 2 carrier-based fighter. It holds three world speed records (500-km closed course, 3-km low-altitude, and 15/25-km straight course), and the sustained-altitude record of 66,443 feet.

USAF Lauds T-38 for Flight Test Safety

NORTON AFB, CALIF.—Northrop Corporation's T-38 Talon was recently acclaimed by the United States Air Force for compiling the best safety record in flight test of any USAF supersonic jet.

In a tribute to pilots as well as the aircraft, an Air Force spokesman said that over 90 T-38's had flown more than 9000 flight test hours without a major accident. The report came from the office of Major General Perry B. Griffith, Deputy Inspector General for Safety.

The T-38 Talon, powered by twin General Electric J85-5 turbojets, is the world's first supersonic aircraft designed expressly for training purposes. Its use as a "supersonic classroom" for space age pilots began late last year.

Chosen for its high safety assurance and versatility, the T-38 features performance capabilities of jet fighters twice its size. With flight capabilities in excess of Mach 1.2, it has exceptional stability and handling qualities in both supersonic and low-speed flight regimes.

The T-38 fills the critical gap between subsonic trainers and supersonic first-line fighters. Aboard the tandem-seat Talon, pilots explore supersonic flight, take-off and landing techniques, multi-jet engine operation, aerobatics, formation flying, night flying, and cross-country navigation.

Each of the aircraft's J85-5 engines is fully capable of powering the aircraft by itself. This factor, combined with dual hydraulic and electrical systems, results in exceptional T-38 safety and reliability margins.

General Electric J85-5 turbojets deliver 3850 pounds thrust each, yet weigh only 555 pounds.

In addition to the T-38, General Electric J85's currently power the GAM-72 SAC decoy missile, the Q-4B target drone, and Northrop's N-156 limited-war fighter, a single-place counterpart of the T-38.

USAF's best flight test safety record for a supersonic jet belongs to the General Electric J85-powered T-38 Talon trainer.

American, Swissair Start Jet Service With Convair 990

CINCINNATI, OHIO—American Airlines and Swissair will be the first major airlines to inaugurate passenger service with Convair's new 990 jetliner.

American, which refers to the aircraft as the 990 Astrojet, is scheduled to start service between New York and Chicago in mid-March.

The new Swissair Coronado began passenger service between Zurich, Geneva, Lisbon, Dakar, Rio de Janeiro, and Buenos Aires in late February.

Newest of the nation's jet transports, the Convair 990 is powered by four General Electric CJ-805-23 aft turbofan engines each rated at 16,100 pounds thrust. Federal Aviation Agency certification for the 990, first jet transport designed specifically around aft turbofan advantages in thrust and fuel economy, came last December 18.

The 990 has transcontinental capabilities, but both American and Swissair will use the aircraft for intermediate-range service. It can land and take off from most airports used by four-engine propeller-driven aircraft, and can cruise at near 600 miles per hour.

The new Convair jetliner was designed with the extra strength, rugged airframe and short takeoff and landing capabilities required for the frequent stops to which aircraft in medium-range operation are subjected.

During FAA testing the 990 made more than 110 takeoffs and landings, and cruised some 76,000 miles on simulated airline schedules throughout the United States. At the time of certification, the six test 990's then flying had accumulated almost 1000 flight hours.

In addition to American and Swissair, REAL/Varig and SAS are also scheduled to add the 990 to their routes.

SEND COUPON FOR FREE BROCHURES

For free bulletins on the G-E engines and propulsion systems discussed above, just check below and send coupon to General Electric, Section A206-43, Schenectady, New York.

- ☐ GED-4450A "T-38/J85"
- ☐ GED-4666 "J85 Engine Family"
- ☐ GED-4114 "J79-Powered Record Holders"
- ☐ SAE-120A "T58 Engine"
- ☐ GED-4125A "T64 Engine"
- ☐ GED-4002 "CJ-805 Engine"

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

GENERAL ELECTRIC

A penny saved may be a penny

wasted in aircraft modification

The only *true* economy in aircraft modification is in getting the best possible quality job—one that will last the lifetime of the aircraft.

There is no compromise with quality at AiResearch. Every job is performed by highly trained and experienced personnel. And each job is checked and double-checked to meet the company's own high standards of quality and safety.

AiResearch facilities contain the most modern equipment available needed to perform any type of aircraft modification required. It is the most experienced company in the complete modification of corporate aircraft, including installation of electronic, electrical and instrument systems.

Send today for our 28-page brochure illustrating and describing AiResearch custom interiors and the company's extensive facilities.

GARRETT

AiResearch Aviation Service Division

International Airport, Los Angeles, California / Telephone: ORegon 8-6161

"MIDGET WITH A PUNCH"

BENDIX DC STARTER GENERATOR LINE FOR LIGHTWEIGHT GAS TURBINE ENGINES—Here are lightweight Bendix® DC Starter Generators specially designed to help start the new, small gas turbine engines fast.

Among other Bendix advantages: High torque at light off speeds with capability of high starter cut-off speeds where required, will carry full load requirements from 7,200 to 12,100 RPM; minimum envelope; self-supplied cooling air up to 20,000 feet; either round, square or QAD flange.

Type No.	Amps	Dia., Inches	Length, Inches	Weight Approx. Lbs.
30856	100	4.6	8	17
30869	150	5.1	8.3	21
30865	200	5.1	9.6	25

Voltage regulation of all these units is handled efficiently by our new, solid state 24815 Static Voltage Regulator

To start gas turbines rated around 250 HP with a DC source, specify one of these powerful "midgets" and get DC power, too. Write us at Eatontown, New Jersey, for further details. Export Sales & Service: Bendix International, 205 E. 42nd Street, New York 17, New York.

Red Bank Division

THE Bendix CORPORATION

Keep your eye on Eimac: for advanced super-power klystrons!

Eimac's quick reaction capability in the high power microwave tube field meets the challenge to deliver faster than ever before. Newest example: X-780—a radar klystron at 75 kw average, 2.5 Mw peak power and frequency range of 1235-1365 Mc. It was developed and put into full-specification radar performance at these L-Band frequencies in only nine months. This super power tube was designed for Lincoln Laboratories of the Massachusetts Institute of Technology. Performing at new limits of electron tube power and frequency, the X-780 will be installed in the Millstone space research high-power, long-range radar—where another Eimac klystron was used to establish positive contact with the planet Venus in 1959.

This is another example of the way Eimac research, development and manufacturing capability are able to meet tomorrow's tube needs today. Another reason to *keep your eye on Eimac*—for advanced high power klystrons, microwave devices and power grid tubes. Eitel-McCullough, Inc., San Carlos, Calif. Subsidiaries: Eitel-McCullough, S.A., Geneva, Switzerland; Nat'l Electronics, Geneva, Ill.

MANAGEMENT ENGINEERED

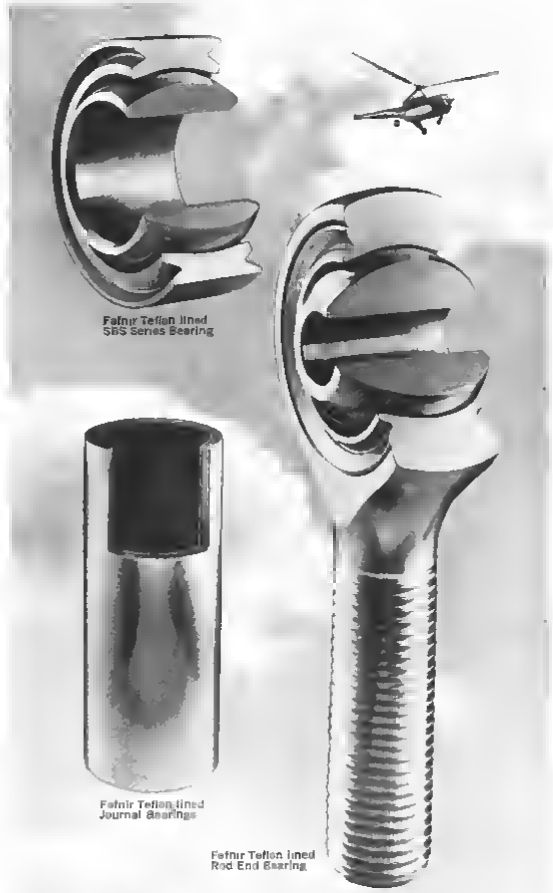
Engineered to meet the major demands of modern management, the Bendix G-20 data processing system is designed to increase profits in an era of critically spiralling costs. ■ Specifically designed as a central, integrated system, the G-20 is capable of concurrently handling the computer workloads of all of your company's major departments—accounting, marketing, engineering, manufacturing, administration, warehousing and distribution. ■ Bendix G-20 automatic programming and linear programming systems open the door to a vast range of applications. For instance, a Bendix G-20 in a typical business organization could, at this moment, be performing these functions: *design automation and cost analysis, inventory control, budget analysis, production and facility control, sales analysis and forecasting, raw material flow, market research and product planning, order processing, advertising planning, and operations research*—all these in addition to more standard business and scientific applications. As workloads increase, G-20 modularity allows you to expand your system without reprogramming. ■ Backing up the proven hardware-software capabilities of the Bendix G-20 is a nationwide team of experienced applications specialists, providing systems support in depth—from preliminary evaluation through systems analysis, programming, installation and on-site maintenance and service. ■ Your nearby Bendix Computer representative will be glad to introduce you to the Bendix G-20 solution to swiftly rising costs; or write for the brochure, "A Solution to the Profit Squeeze," Bendix Computer Division, 5630 Arbor Vitae Street, Los Angeles 45, California, Dept. AF 39.

Bendix Computer Division

THE BENDIX G-20 COMPUTING SYSTEM

NOW IN OPERATION—Battelle Memorial Institute, Columbus, Ohio

New! For high quality... high reliability...
FAFNIR Teflon*-lined Bearings



To meet increasingly critical reliability requirements in high-performance aircraft, Fafnir announces development of a new line of Teflon-lined bearings.

These new bearings — made to highest quality standards — incorporate unique Fafnir features.

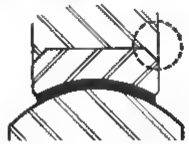
A circumferential groove in the face of the outer ring of SBS Series Spherical Bearings, for example, *permits roll-swaging of the bearing to the housing, rather than housing to bearing.* Expensive housings remain unaltered, undamaged. Bearing thrust capacity and resistance to vibration are increased.

Fafnir Teflon-lined Bearings are available in spherical, rod end, and journal types. They are self-lubricating and provide low-torque performance under severe loadings. The Teflon liners are shock-resistant and chemically inert.

Look to Fafnir when design calls for Teflon-lined bearings — and where service calls for maximum reliability. Write for the new Fafnir Teflon-lined Bearing Bulletin. The Fafnir Bearing Company, New Britain, Connecticut.

*DuPont's trade-mark for TFE Fluorocarbon fibre woven fabric

NEW — Fafnir SBS Bearing outer ring swaged over housing chamfer.



CONVENTIONAL — Housing chamfer swaged over Fafnir BS Bearing outer ring.

FAFNIR
BALL BEARINGS

dead center

Kelsey Hayes thrust vectoring systems give missiles proper directional control

Kelsey Hayes is contributing substantially to the design, development and production of new thrust vector control systems for solid fuel propulsion

For example Kelsey Hayes, in a recent crash program, designed and fabricated a movable nozzle control that passed static firing tests for one of the newest sophisticated missile systems

The swivel nozzle control is just one of the latest developments by Kelsey Hayes as a subcontractor of propulsion subsystems, flight componentry and high performance materials. Spearheading Kelsey-Hayes activities is the Advanced Design Group, a flexible team of experienced design specialists. Kelsey-Hayes Company, Romulus, Michigan.

KELSEY HAYES COMPANY

Automotive, Aviation and Agricultural Parts
Hand Tools for Industry and Home

OPERATIONAL PLANTS: Detroit, Jackson and Romulus, Michigan; Los Angeles, California; Philadelphia, Pennsylvania; Springfield, Ohio; Utica, New York; Davenport, Iowa; Rockford, Illinois; Windsor and Woodstock, Ontario, Canada.

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Cold-Finishing of Alloy Steel Bars: Turning and Polishing

Continuing our discussion of the cold-finishing of alloy steel bars, we take up the subject of turning and polishing. A later discussion will cover grinding and polishing. Both require removal of surface metal. In both the turning and grinding operations, adequate allowances provide for the removal of decarburization and surface defects which sometimes occur in alloy bars.

As previously stated, the outstanding advantage of cold-drawn bars over hot-rolled bars is the *bright, smooth finish*. However, the quality of the cold-drawn finish varies with the size and amount of draft (reduction of cross-sectional area) applied in cold-drawing. For example, by using a 1/16-in. draft, a 3/4-in. round would have a better cold-drawn finish than a 3-in. round.

When a superior mirror-like finish with additional accuracy is required on surfaces that are not machined (such as on shafting or machine parts), two processes other than cold-drawing are suggested: turning and polishing, and grinding and polishing. The first of these is discussed here.

Turning and Polishing. This method of cold-finishing is generally associated with centerless bar-turners, accommodating rounds from 1 1/4-in. to 6-in. diameter, inclusive. The process is the reverse of conventional lathe-turning, which is normally used for larger sizes. The centerless turning equipment uses two cutter heads which contain from one to four cutting tools. The system provides for both rough and finish cuts. The bar, which is stationary, is fed horizontally into the rotary cutter heads by means of a mechanical or hydraulic feeding mechanism. Most bar-turners are equipped with a series of polishing rolls that also rotate around the bar as it feeds from the rotary cutter heads. This, combined with subsequent burnishing action from the straightening rolls, imparts a high degree of polished finish to the product. A polished surface on a turned bar can also be produced by a number of passes through the straightening rolls.

This process is applicable to normalized, annealed, or heat-treated carbon and alloy bars. It does not materially affect the mechanical properties.

Bethlehem metallurgists will gladly work out any problem in the cold-finishing of alloy steel bars. Always feel free to ask for their services.

When you need steel remember, too, that Bethlehem manufactures the entire range of hot-rolled AISI standard alloy grades, as well as special analysis steels and all hot-rolled carbon grades.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

Steel

for Strength
Economy
Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales: Bethlehem Steel Export Corporation*

BETHLEHEM STEEL

BETHLEHEM STEEL

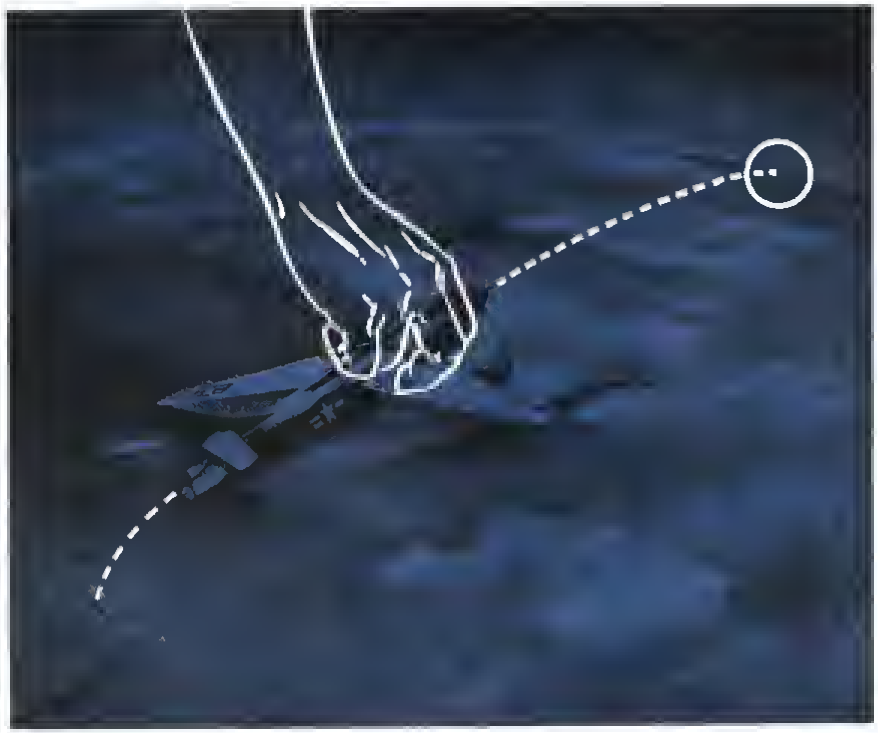
On the North American A3J Vigilante, new Navy all-weather attack aircraft with speed in the Mach 2 range, PLEXIGLAS *55 acrylic plastic is used for the curved windshield and pilot's canopy.*

WHERE THERE'S PROGRESS, THERE'S PLEXIGLAS®

ROHM & HAAS

PHILADELPHIA 5, PA.

In Canada: Rohm & Haas Company of Canada, Ltd., West Hill, Ontario



SILENT PARTNER
from take-off to target to bomb-drop and return

The crew aboard a Navy Douglas Skywarrior bomber has been relieved of many exacting, exhausting tasks by the AN/ASB-7 all-weather navigation and bomb director system. Norden is serving as the systems manager for the ASB-7, whose sub-systems provide every function required. Doppler type radar gives speed data. An accurate dead reckoning system provides course, direction and position. Stabilization is provided by a Norden three-gyro platform. Search radar reveals targets, in all weather, at all distances within radar range and an optical system provides a direct view of ground and target. Finally, computing units coordinate the entire system . . . achieving a high degree of automation *from take-off to target to bomb-drop and return.*

The AN/ASB-7 is a network of sophisticated electronic and mechanical sub-systems achieving a system of high accuracy and reliability. And it is another demonstration of Norden's capability in the advanced areas of electronics systems engineering . . . technical talents devoted to extending man's capabilities.

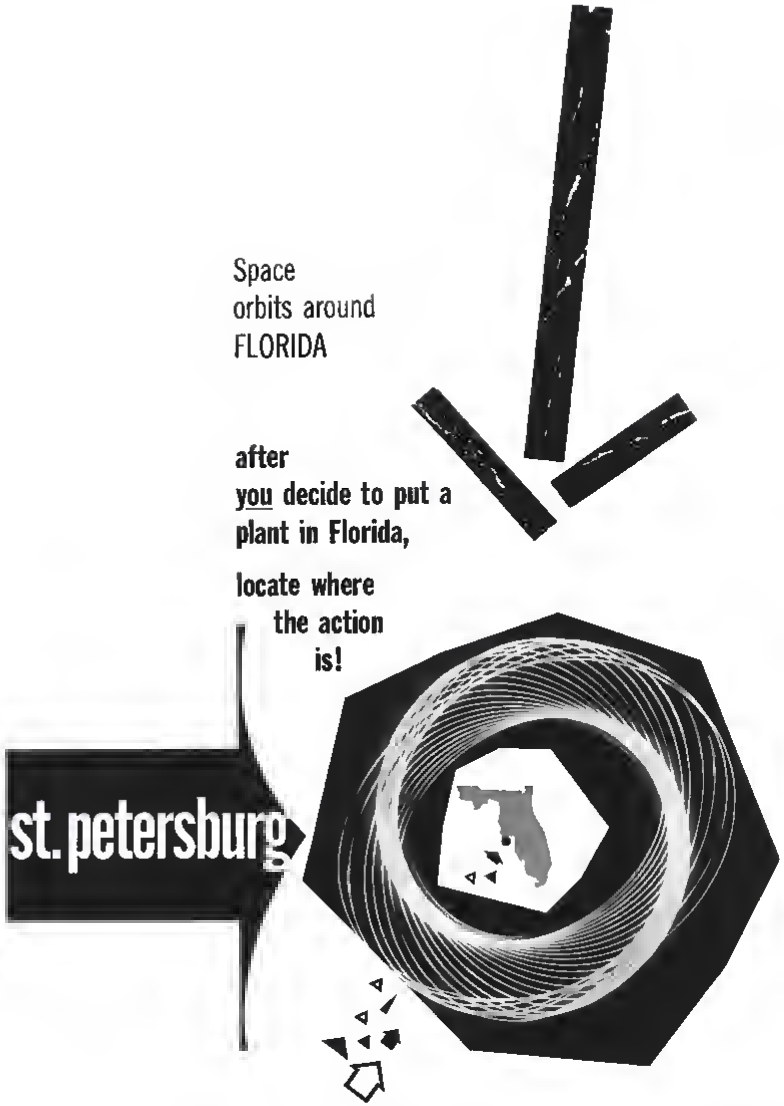
For additional information about the Norden all-weather navigation system and other avionic systems, write

Norden DIVISION OF UNITED AIRCRAFT CORPORATION
NORWALK CONNECTICUT

NORDEN

Space
orbits around
FLORIDA

**after
you decide to put a
plant in Florida,
locate where
the action
is!**



The control of space is in Florida . . . because the people who will control it live here. Why not? It's nicer living here. And St. Petersburg land prices are within reason. Come and get it . . . locate where the action is—St. Petersburg. Write, wire or phone in confidence ▶ **GREATER ST. PETERSBURG CHAMBER OF COMMERCE, Jack Bryan, Dept. A, St. Petersburg, Florida**

St. Petersburg is the Florida Home of ALLSTATE INSURANCE • AMP • BABCOCK & WILCOX • CONTINENTAL OPTICAL • EGI • GENERAL CABLE • GE • GENERAL NUCLEAR ENGINEERING • INTERNATIONAL RESISTANCE • MILTON ROY • HONEYWELL • SPERRY

FAR OUT

One of the most advanced nuclear projects of our time is the development of SNAP compact reactors for space. Atomics International is deeply involved in this "far out" work. AI is developing a series of compact reactor systems that will be used in space for communications and will also have world-wide TV applications as well as stationary and mobile terrestrial uses. Their development is a challenge worthy of the most dedicated engineer or scientist.

Immediate opportunities are available in:

Core Analysis—Core analysis of compact reactors including both core statics (criticality, reactivity coefficients, control statics) and stability analysis (core transients, amplitude response, interpretation of oscillator and noise measurements).

Heat Transfer—Senior Engineers to be responsible for system engineering studies on the thermal, hydraulic and thermodynamic performance of compact power reactor systems.

System Analysis—Analysis and simulation of complete nuclear power plants to develop reliable unattended, completely automatic control and instrumentation systems, including reactor kinetics, dynamics, hazards and reliability analysis.

Hazards Analysis—System safety and hazards studies on compact nuclear power systems for space applications. Background in radiation shielding and radiological hazards evaluation desired.

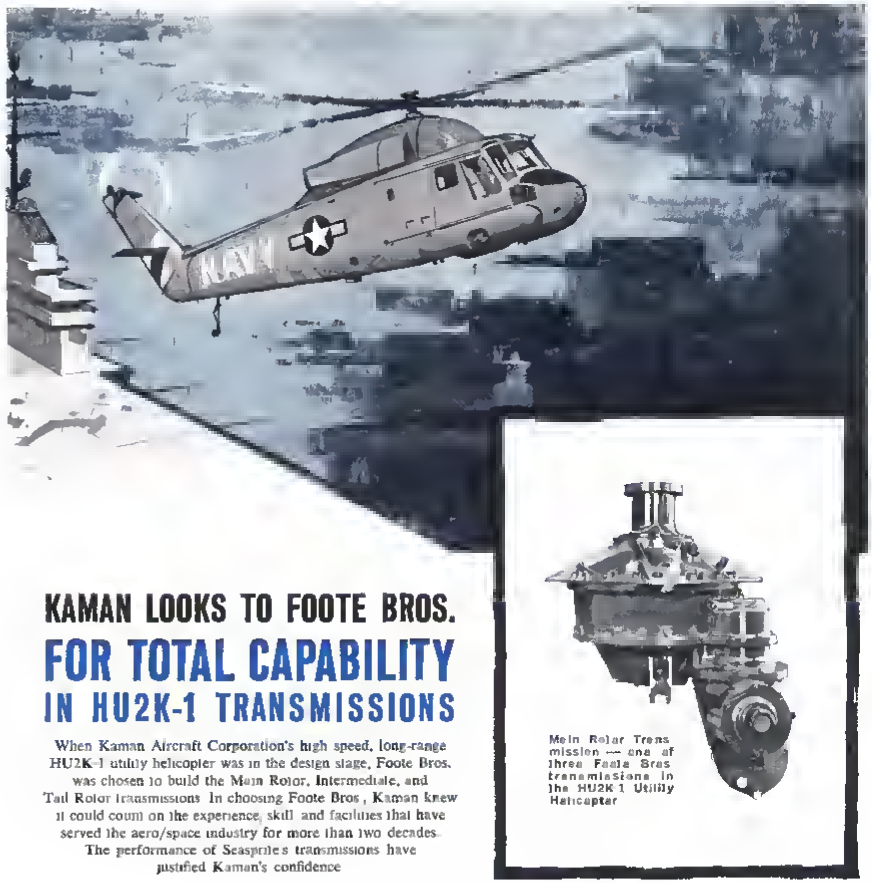
Control Analysis—Dynamic control and simulation studies to establish stability and control specifications for compact nuclear power plants being developed for space applications. Familiarity with latest analog and digital techniques required.

Space Environmental Testing—Component development and space environmental testing of nuclear power plant components including high vacuum, vibration, shock, thermal and orientation testing.

Please contact: Mr. G. P. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, Calif.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

ATOMICS INTERNATIONAL
Division of North American Aviation



Main Rotor Transmission — one of three Foote Bros. transmissions in the HU2K-1 Utility Helicopter

KAMAN LOOKS TO FOOTE BROS.
FOR TOTAL CAPABILITY
IN HU2K-1 TRANSMISSIONS

When Kaman Aircraft Corporation's high speed, long-range HU2K-1 utility helicopter was in the design stage, Foote Bros. was chosen to build the Main Rotor, Intermediate, and Tail Rotor transmissions. In choosing Foote Bros., Kaman knew it could count on the experience, skill and facilities that have served the aero/space industry for more than two decades. The performance of Seasprite transmissions have justified Kaman's confidence.

Foote Bros. offers coordinated facilities in these areas:

DESIGN
A completely staffed Design Engineering Group with a solid record of achievement in systems and component design and development.

DEVELOPMENT MANUFACTURING
Long experience in working with many prime contractors gives us the ability to move quickly and surely to successful completion of preliminary development.

TEST PROGRAMMING
Extensive test facilities plus test stand design and procedure experience ensure to the latter compliance with specifications.

PRODUCTION
Foote Bros. production facilities and craftsmen are keeping pace with the ever-increasing demands of the aero/space industry for greater product reliability.

Foote Bros. total capability is at your service. Your inquiry is invited.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

POWER TRANSMISSION DRIVES

Circle Number 39 on Reader Service Card

This is General Motors Defense Research Laboratories

. . . working in the national interest

GENERAL MOTORS

DEFENSE RESEARCH LABORATORIES

SEA OPERATIONS: Today top-flight scientists at GM/DRL are at work in, on and under the sea prying out the ocean's secrets. From their studies can come detailed knowledge pointing the way to more precise methods of underwater tracking, navigation, undersea charting and marine vehicle mobility.

LAND OPERATIONS: All scientific knowledge is utilized in GM/DRL's search for more effective systems operating in the surface environment. Research into terra mechanics, articulated vehicles and electronics is resulting in new systems for tactical warfare and lunar and planetary exploration.

AERO/SPACE OPERATIONS: From the earth's surface to the farthest reaches of outer space . . . from the study of hyper ballistics to space systems . . . new propulsion methods to sophisticated theories of quantum electronics . . . GM/DRL is dedicated to man's survival in the universe about us.

BIOLOGICAL STUDIES: "To extend our knowledge and capabilities in the biological sciences and technologies, expanding our understanding of men in relation to this and other environments through creative research and exploratory development programs." This is the mission of GM/DRL scientists.

GENERAL MOTORS DEFENSE RESEARCH LABORATORIES, SANTA BARBARA, CALIF.

Vacuum Deposited Coatings in Space

Keeping an object in space cool is one of the major problems facing the space systems engineer. The efficiency of solar cells which convert radiation to electrical energy and provide power for the satellite, depends upon the maintenance of low temperatures. Unfiltered solar energy would cause cell temperatures to soar and energy output to drop. ■ To maintain low cell temperatures, and at the same time allow passage of usable wavelengths, Optical Coating Laboratory has developed a variety of highly efficient solar cell covers. When placed between the cell and the sun, these covers selectively reflect away wavelengths not used in the energy conversion process, lowering cell temperature and ensuring optimum power output. ■ A revolutionary development in this field is OCLI's ultraviolet-infrared reflecting solar cell cover. Although this remarkable "Blue-Red" cover was only developed eighteen months ago, it is already in volume production and is used on ADVENT and NIMBUS power systems. ■ Numerous other products are manufactured at OCLI for government and industry. OCLI engineers and physicists are specialists in the design, development, and volume production of single and multilayer vacuum deposited films. Capabilities range from the far ultraviolet to the far infrared. ■ For further information on OCLI thin film products for both military and industrial purposes, contact:

OPTICAL COATING LABORATORY, INC.

2789 GIFFEN AVENUE • SANTA ROSA CALIFORNIA • TELEPHONE 707 LI 5-5440 • TELETYPE ZR 33

HONEYWELL ADAPTIVE CONTROL SYSTEM NOW FLIES THE X-15

EXTRA HIGH RELIABILITY AND SAFETY BUILT INTO X-15 SYSTEM Extraordinary demands placed upon both man and machine in a typical X-15 mission require extremely high reliability and safety factors. The Honeywell adaptive system will inherently adjust to maintain satisfactory performance should one of its electronic elements fail. By duplicating many critical elements Honeywell engineers have been able to design the X-15 system to "bridge across" not only single failures but most multiple malfunctions (highly unlikely to occur). Furthermore, each part has been designed with an extra margin of reliability. All these factors contribute to make the X-15 system the safest flight control system ever flown.

Flight-proven, qualified system gives uniform control throughout vast range of speeds and altitudes

A reliable automatic flight control system that adjusts itself to the entire range of aero space flight dynamics—this is the new Honeywell Adaptive Autopilot developed under the auspices of the Flight Control Laboratory, ASD, Air Force Systems Command, and now flying one of the X-15 rocket research vehicles. Proved in hundreds of hours of flight tests in a supersonic F-101A, the performance of the adaptive system has been enthusiastically accepted by 18 experienced Air Force, Navy and NASA test pilots.

Unlike conventional linear autopilots the Honeywell Adaptive System does not require continuous information such as air density and speed. Instead, the system maintains control by continuously measuring its own response and adjusting itself to keep that response optimum under all flight conditions.

As the X-15 climbs toward thinner air, the Honeywell Adaptive System automatically adjusts the control surface displacement and blends the reaction jets with the conventional aerodynamic controls until, at a very high altitude, the reaction jets alone must steer and stabilize the craft. During re-entry, as the air gets thicker, the system blends in the aerodynamic controls as they become effective. This conserves reaction jet fuel and gives the pilot full command of the critical re-entry maneuver.

While it provides effective flight control throughout an extremely wide dynamic range, the Honeywell Adaptive System requires far less advance knowledge of the aerodynamic characteristics of the craft to be flown (some of the X-15's characteristics are still unknown), and requires far less flight proof time (the flight controls in the X-15 will be fully flight proven in 40 minutes).

Honeywell is designing and building a similar Adaptive Flight Control System for the Dyna Soar manned space glider, and is using the same basic principles for other applications such as business aircraft, helicopters, drones, supersonic fighters, and bombers, as well as missiles and rockets.

The X-15 is manufactured by North American Aviation for the joint Air Force-NASA and Navy research project. It has made substantial contributions to the knowledge of man's ability to function effectively in spacecraft, and it is furnishing valuable facts to supplement theory on structures, metals, fuels, engine performance, and design techniques.

For further information on Honeywell's space and weapons systems capabilities, write Honeywell Military Products Group, Minneapolis 8, Minn. Dept. AW-3-36.

This advertisement is paid for by Honeywell, not from government funds. While it is a report concerned with our nation's defense and space exploration programs, it is primarily intended to acquaint you with Honeywell's capabilities. It is particularly addressed to companies seeking help in areas where Honeywell research and practical experience can be most useful. Your inquiries are invited. This material has been cleared for publication by the Government agencies, contractors and companies concerned.

Airborne analyzer conducts "Go, No-Go" equipment checkout

A Honeywell developed Airborne Checkout System is carried aboard the B-52 mothership. Connected by an umbilical cord to the X-15, it automatically makes 78 separate pre-flight checks on the operation of the X-15 flight control system in less than 3 minutes. At the push of a "Start" button the analyzer first self-checks its own operation, then checks each of the 78 circuits in the flight control system. If any circuit is not functioning properly the analyzer stops and indicates which circuit is faulty. The operator then decides whether it is a serious enough malfunction to call off the flight or whether it is a minor matter which the pilot can override. If the decision is to override, the operator again pushes the "Start" button and the analyzer completes the checkout.

Computer center solves space, business problems

A battery of analog computers was used to conduct flight simulation studies in analyzing the requirements of the X-15 Adaptive System. Now in a Honeywell Computer Center, these analog computers are coordinated with a Honeywell 800 digital computer into one system. (A digital computer displays its answers in numbers; an analog computer produces results in graph form.) This is believed to be the first installation in industry to perform both analog and digital scientific computation while simultaneously handling business problems.

The center will handle the huge amount of computation involved in the development of control systems and will even be used to solve the problem of scheduling its own time to meet the needs of the many departments it will serve.

Honeywell

Military Products Group

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France and Japan.

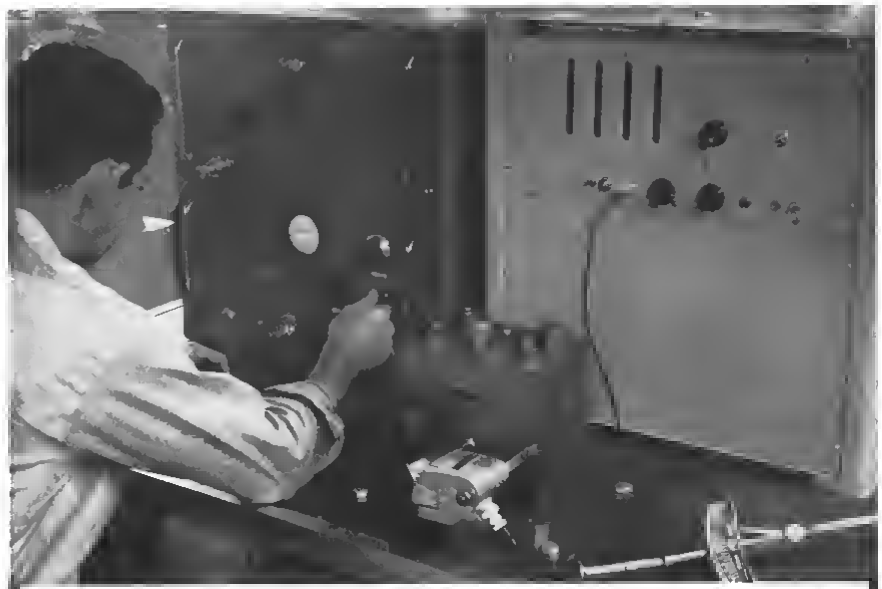
Until aircraft are made fireproof

When fire detection is an afterthought, everybody pays builder, operator, and passenger. False alarms, redesign "fixes" and general inconvenience have given this vital safety system a bad name. Why?

Too often fire detection *is* an afterthought. The engineer must "fit it in"—rather then "design it in." Systems are chosen without knowing how they will perform. Components are located where they do little good — or are inherently subject to damage. But this need not be.

Here at Fenwal we've grown up with aircraft fire detection. We've equipped hundreds of planes, and worked with even more layouts. If you invite us in early enough, our experience can improve your detection system. Because *only* Fenwal has a complete line of proven detection equipment, we can give you absolute objectivity and recommendations based on a solid experience foundation. Just call us for more information. Fenwal Incorporated, 123 Pleasant Street, Ashland, Massachusetts.

Fenwal



ONLY A FEW DART ENGINES WILL EVER NEED THIS EQUIPMENT

...Yet These Engines Would Not Be Reliable Without This Mod.

Certain early model Rolls Royce Dart engines developed mysterious low pressure blade failures. The trouble was traced to a destructive resonance set up when the natural blade frequency coincided with the vibration frequency of the engine at cruise power.

The cure was to crop the blades . . grind away part of the shroud. This lowered the resonant frequency of the blades. But unless that new frequency was well below the engine cruise frequency, it might still be dangerous.

The only way to make sure the blades are safe is to measure their natural frequency and make sure it lies well below the turbine operating frequency. That's why Airwork has installed the unusual analyzing equipment shown above. A transducer excites the blade, and the frequency developed is both analyzed by an oscilloscope and counted electronically. Each blade must fall within certain vibration limits, or it is cropped until it does.

Only a few Dart engines will ever need this expensive equipment. Airwork installed it to make sure those engines that needed it were properly overhauled. You can be sure if your engine needs the unusual type overhaul skill or equipment Airwork will have it. It is part of our basic philosophy of always producing the most reliable engines possible.

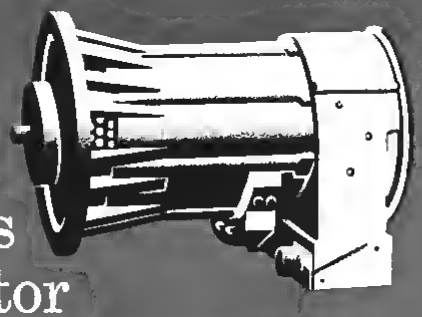
Airwork

ESSENTIAL AVIATION SERVICES

Airwork CORPORATION Millville, New Jersey

Circle Number 45 on Reader-Service Card

AC/DC Brushless Generator



New Concept / simplicity

When you seek a generator system proposal for your airborne or ground support project, call in Leland. We're ready to suggest our new AC/DC brushless generator to give you optimum output and compactness, maximum reliability, and very low wave form distortion—free from damaging spikes. We are building this kind of refined hardware right now for helicopter service!

Generator illustrated has AC and DC stator windings within one magnetic structure as well as all the advantages of brushless construction. In the speed range 7,200 to 9,200 rpm it puts out 120/208 volts AC, 3 phase, 400 cycle, 30 KVA or 24 KVA AC and 200 amp, 28 volts DC. The machine is 8" in diameter by 8" long and weighs approximately 73 pounds. It is more reliable because there are fewer parts in this simplified design.

We can regulate AC alone with inherent DC regulation, or regulate both AC and DC independently—each within 1.5%. Any degree of system protection and automatic control can be provided.

Leland AC/DC brushless generators can make significant weight and space savings for your next helicopter, VTOL, STOL or other aircraft type, turbine or conventional powered ground equipment. We're geared to move quickly on your project. Ask for bulletin LA-3 from Leland Airborne Products, Division of American Machine & Foundry Company, Glendale, Ohio.

AMF

LELAND AIRBORNE PRODUCTS

CARIBOU STOL PERFORMANCE PLUS 5 BIG BONUS FEATURES

CARIBOU STOL PERFORMANCE—Take-off distance 725 feet, zero wind, at full gross load, 28,500 lbs

PLUS: 1. Quick Turn Around. Cargo rolls straight in through rear loading door. Ramp adjusts to truck bed height. Long loads can extend out open door in flight.

PLUS: 2. Big Load Capacity. 32 troops or 24 paratroopers. 1150 cubic foot cargo space.

PLUS: 3. Paradrop. Rear door facilitates air drops. Paratroopers—jeeps—pallets up to 6,000 lbs

PLUS: 4. Drive-in. Accommodation for 2 jeeps and carrier, or equivalent.

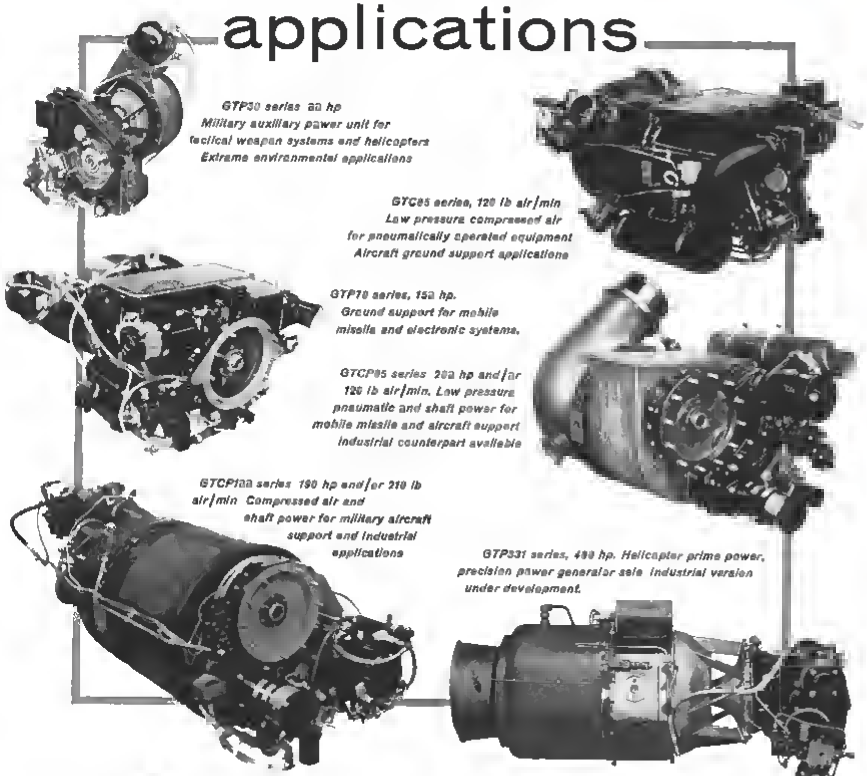
PLUS: 5. Ambulance. 14 litters and 12 seats, or 22 litters and 4 seats.

THE STOL
CARIBOU
DESIGNED AND BUILT BY
DE HAVILLAND AIRCRAFT OF CANADA
DOWNSVIEW ONTARIO

CANADA

WASHINGTON REPRESENTATIVE, J. E. McDONALD,
319 TOWER BUILDING, 14th & K STREETS, N.W.

Small Gas Turbines for diversified power applications



GTP30 series 30 hp
Military auxiliary power unit for tactical weapon systems and helicopters
Extreme environmental applications

GTC85 series, 120 lb air/min
Low pressure compressed air for pneumatically operated equipment
Aircraft ground support applications

GTP70 series, 150 hp.
Ground support for mobile missile and electronic systems.

GTCP85 series 280 hp and/or 125 lb air/min. Low pressure pneumatic and shaft power for mobile missile and aircraft support
Industrial counterpart available

GTCP180 series 190 hp and/or 210 lb air/min Compressed air and shaft power for military aircraft support and industrial applications

GTP331 series, 400 hp. Helicopter prime power, precision power generator sets Industrial version under development.

Garrett's AiResearch gas turbines are now operating in an extremely wide variety of industrial, commercial airline and military applications with power requirements up to 500 hp.

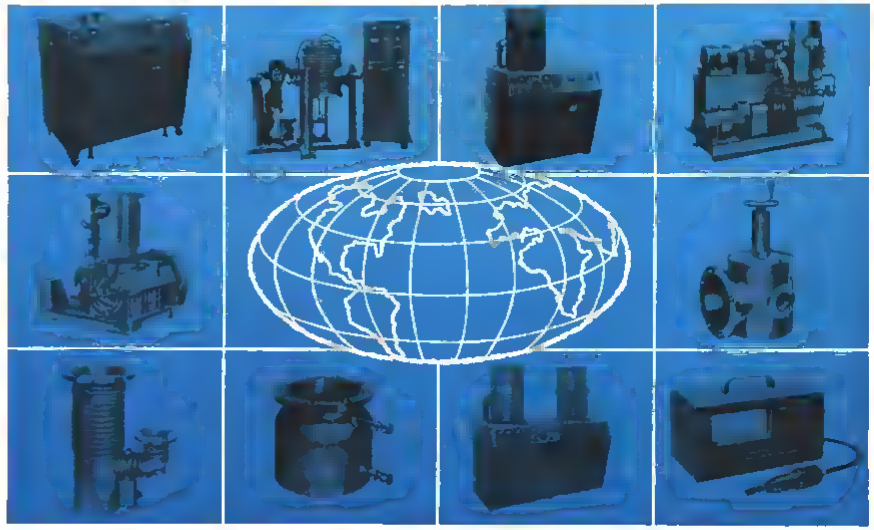
Now competitively priced with other types of engines, these reliable power units run on almost any fuel and start immediately in any weather

Prime and auxiliary power applications of AiResearch gas turbines include aircraft and missile support . . small independent generator plants. marine use. . helicopters . . emergency power plants. . air conditioning, heating and refrigeration. . precise power generation. . . nuclear and solar energy (closed cycle turbine).

AiResearch Manufacturing Division of Arizona has produced 9000 gas turbine engines of all types now in operation. Please direct your inquiries to Gas Turbine Sales, Phoenix Division.

GARRETT **AIRESEARCH MANUFACTURING DIVISIONS** • *Los Angeles 45, California • Phoenix, Arizona*

Systems and Components for
Aircraft, Missile, Spacecraft, Electronic, Nuclear and Industrial Applications



LEADERSHIP

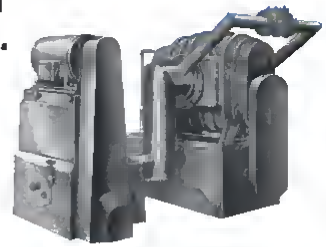
with a forward look in the field of high vacuum equipment . . .

Kinney Vacuum, the accepted leader in the manufacture of vacuum pumps is acknowledged foremost in research and development in the high vacuum industry.

This leadership is carefully guarded by constant and extensive research and development that produces the ultimate in mechanical pumps, diffusion pumps, valves, baffles, gauges, vacuum furnaces, space chambers, and complete vacuum systems.

The resources of the New York Air Brake Company and all of its divisions guarantee every Kinney Vacuum product to be efficient in operation, most modern in design, and constructed to give the maximum in service.

- PROVEN STABILITY
- EXTENSIVE RESOURCES
- DYNAMIC DEVELOPMENT



MECHANICAL BOOSTER PUMPING SYSTEM . . . KMBV-5000-500

This 5000 cfm system combines a lobe-type booster pump with a new and original triplex pump in a vibrationless compact package operating automatically from atmospheric pressure to a blank-off of 2×10^{-4} torr. A by-pass roughing line reduces the time required to reach the booster pump cut-in pressure. Chief assets are high pumping capacity over a wide pressure range, freedom from oil vapor backstreaming and long dependable service under the severest applications. Booster pumping systems such as this evacuate chambers for hypersonic wind tunnels and shock tubes, chambers for testing plasma and ion engines and intermediate altitude chambers.

KINNEY VACUUM DIVISION THE NEW YORK AIR BRAKE COMPANY
3529 WASHINGTON STREET • BOSTON 30, MASS.

PROVEN SELF-CHECK MINIATURE RATE GYROS AVAILABLE FROM PRODUCTION

Self-check in a *miniature* rate gyro is now available from Honeywell in the Model MS-100. This gyro combines *independent* self-check circuitry with the unique features of the reliable M-100 miniature rate gyro. The same self-checking techniques successfully proven in Honeywell Model JRS Gyros on current missile programs are applied to the Model MS-100.

In Honeywell's independent self-check circuitry both a simple wheel-speed test (SMRD) and a gimbal torquer are provided for true verification of the gyro's readiness to perform. Torquer and Spin Motor can be checked simultaneously to verify gimbal freedom, pick-off integrity, spring performance, wheel speed and damping ratio.

Other features of the Model MS-100 include virtually constant damping from −65°F to +250°F and a unique quadrilever spring construction for greater shock and vibration resistance.

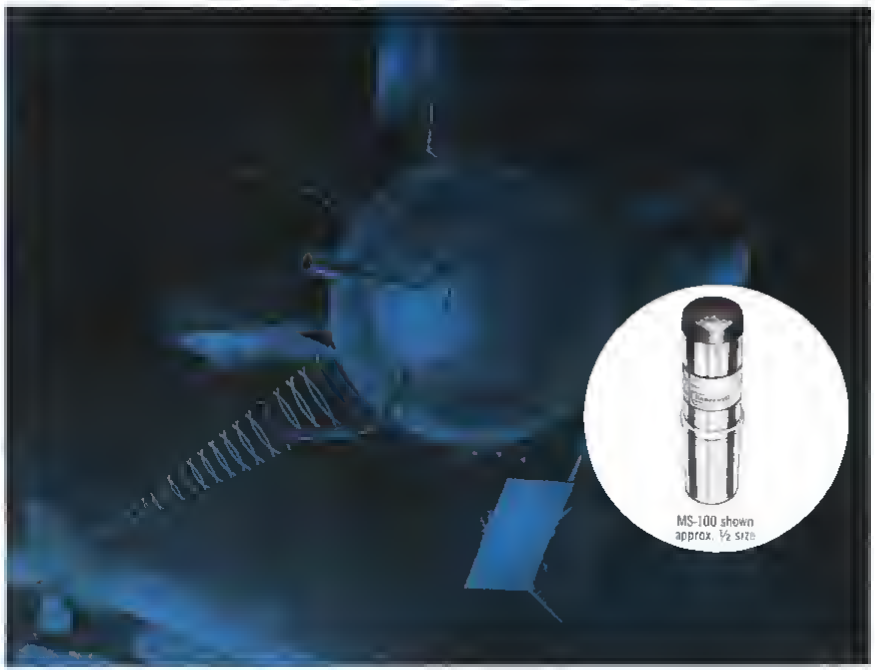
Gyro performance data: LINEARITY as low as 0.1% of full scale . . . HYSTERESIS 0.1% of full scale . . . THRESHOLD less than 0.01 deg/sec . . . MICRO-SYN PICK-OFF variable reluctance type, providing infinite resolution and high signal-to-noise ratio . . . FULL SCALE RATE as low as 10 deg/sec . . . SENSITIVITY up to 200 millivolts/deg/sec . . . RUGGED withstands 300 g shock . . . VIBRATION operates at 30 g to 2,000 cps, sinusoidal; 1.0g² per cps, over 2,000 cps bandwidth.

The small size, high performance and proven reliability of the Model MS-100 make it particularly suitable for advanced aircraft, missile and satellite programs. In one orbital application, for example, the MS-100 will be started and self-checked on command to reference the correction for spin stabilization of a satellite.

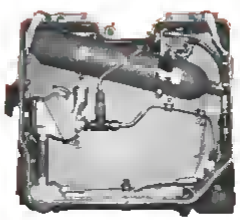
Honeywell's flight control components and engineering experience are available to assist in the solution of your gyro and packaging problems. Write for Bulletin MS-100 to Minneapolis-Honeywell, Boston Division, Dept. 2, 1400 Soldiers Field Road, Boston 35, Mass., or call your local Military Products Group office. Sales and Service offices in all principal cities of the world.

Honeywell

Military Products Group



Scott put the LIFEGUARD on the "Vigilante"



Scott life support components for the A3J are integrated into the compact individual crewman's survival kit assembly

The pilot and bombardier/navigator in the Navy's A3J "Vigilante" attack bomber are protected at all times with SCOTT lifeguard equipment. Scott provides the pressure control and oxygen system that supports the Navy's full-pressure suits worn by both crewmen, automatically controlling ventilation throughout the entire profile of the mission. Built-in emergency capability takes over automatically in the event of ship's oxygen supply loss or air crew ejection. During ejection sequence, the Scott survival kit system rides with the man until safe altitude is reached.

The "Vigilante" installation is typical of Scott's capability in the research and development of versatile environmental control and life support systems to meet fast-changing requirements in aviation and aerospace fields.

Find out how Scott can help *you* meet the challenge in the air and in the space beyond. Send for your copy of the free booklet: "Preparing for Tomorrow—Producing on Schedule Today."

SCOTT AVIATION CORPORATION

DEPT. B-32 LANCASTER, NEW YORK

Export: Southern Oxygen Company, 3 West 57th St., New York 19, N. Y.
West Coast Office: Fulton Venture Bldg., 13273 Ventura Blvd., Studio City, Calif.
Great Britain Affiliate: The Weller Kidde Company, Ltd.

Any or all Time Codes...

off-the-shelf from ASTRODATA

ASTRODATA can give you, in *one standard* instrument at *standard* instrument prices, any presently used time code format or up to 8 codes simultaneously. You can choose from more than 30 standard options, all immediately available off-the-shelf. Only Astrodata can honestly make this offer.

Astrodata's complete line of solid state time code equipment is built to MIL requirements around modular plug-in circuit cards. Right now cards are on the shelf for all time code formats in use today, including IRIG Members A, B, C, and D, NASA 36-, 28- and 20-bit, Atlantic and Pacific Missile Ranges, Eglin, White Sands, etc.

Using these standard modules, and combinations thereof, Astrodata supplies "custom" generators/translators in the shortest possible time and for the lowest possible price. No costly engineering design is involved.

Astrodata's approach also avoids early obsolescense. The user can add and subtract modules with ease, instead of a complete new generator or translator, he orders new cards as he would spare parts. As new code formats are developed, Astrodata develops new plug-ins at once.

We invite you to investigate, and will be happy to supply names of customers in your area.

Example of Astrodata Time Code Equipment

SERIES 6190 TIME CODE GENERATOR

Available for generating all time code formats, stability, 1 part in 10^9 per day with internal frequency standard, also precise synchronization to external frequency standards. multiple, simultaneous serial time code outputs. 8 simultaneous pulse rate outputs, (1 mc per second to 1 per minute). 3 optional interchangeable plug-in power supplies (60 cps, 400 cps, 28 v/dc), completely transistorized.

Free TIME CODE FORMATS

New brochure includes all commonly used time code formats compiled for easy reference, and details on Astrodata equipment. For your copy, write to Astrodata, Inc., 240 E. Palais Road, Anaheim, California. Phone PR 2-1000 or TWX AH 5327.

ASTRODATA INC. *Successors to Epsco-West*
ANAHEIM, CALIFORNIA

Flexonics products, services, and facilities for the aerospace industries . . .

PRODUCT APPLICATION ENGINEERING

Nowhere will you find a broader background in the design and application of flexible and lightweight tubular components for aircraft and missiles than at Flexonics. Flexonics engineers —both in the field and in the plant—draw on a line of experience that includes participation in most of the United States major aircraft and missile programs. Use this experience to assist in solving your design problems.

METAL HOSE and CONNECTORS

Flexonics offers the broadest line of flexible metal hoses and connectors in corrosion resistant alloys for aerospace applications—to solve the problems caused by vibration, misalignment, thermal motion, and pressure impulse. Sizes from ¼" I.D. through 12" I.D.; readily adapted for use with MS fittings, flanges, or couplings, or with special terminations.

FLEXIBLE JOINTS and DUCT ASSEMBLIES

Both free-flexing and self-restrained flexible joints for assuring system flexibility under conditions of vibration or thermal change. Proved in many critical applications such as propellant lines, vent and pressurization ducts, cabin air pressure systems, and gas turbine engines. Components or complete ducting systems, including high strength, thin wall corrosion resistant tubing.

CRYOGENIC CLEANING FACILITIES

Flexonics facilities for cryogenic product applications include one of the most advanced and outstanding cleaning facilities in the United States. The exclusive techniques developed for cryogenic cleaning of Flexonics products are also available for cleaning of other products on a contract basis. Why not inquire about using this approved and certified facility for your own products?

Here are the facilities—for research, engineering, manufacturing, fabrication, cleaning and qualification testing—that make possible a single responsibility on aircraft and missile ducting systems. Only at Flexonics will you find this fully integrated service. To make your own design job easier, submit it to Flexonics as early as possible in the development stage.

Mail the coupon today! Check your field of interest and clip the coupon to your letterhead.

Flexonics
DIVISION OF CALUMET & HECLA INC.
232 East Devon Avenue • Bartlett, Illinois

FLEXIBLE METAL and SYNTHETIC HOSE
EXPANSION JOINTS
BELLOWS • SPECIAL TUBULAR ASSEMBLIES

In CANADA
FLEXONICS CORPORATION OF CANADA, LTD.
BRAMPTON ONTARIO

ATTACH TO YOUR LETTERHEAD

Flexonics
232 East Devon Avenue
Bartlett, Illinois

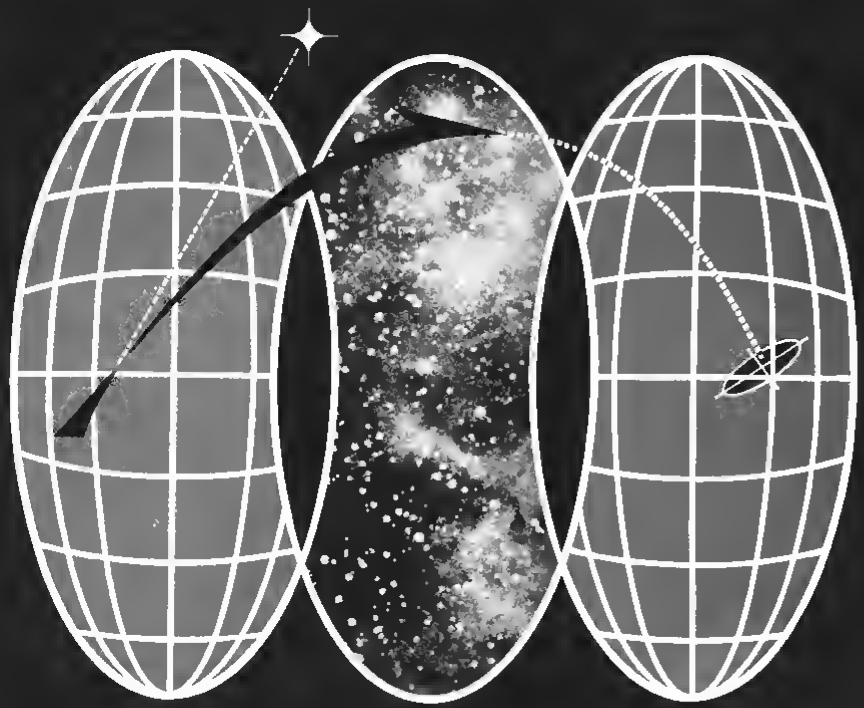
Please send me literature on the subject that I have checked:

- ☐ Metal Hose and Connectors
- ☐ Cryogenic Cleaning
- ☐ Flexible Joints and Duct Assemblies
- ☐ Qualification Testing

GENERAL PRECISION & STELLAR INERTIAL GUIDANCE SYSTEMS

A contract for production and testing of a Stellar Inertial Guidance System for ballistic missiles has recently been awarded to General Precision by the United States Air Force. Using the stars as reference points, this highly advanced missile-borne system employs a General Precision celestial sensor integrated with a miniature inertial guidance system to deliver the missile to its target.

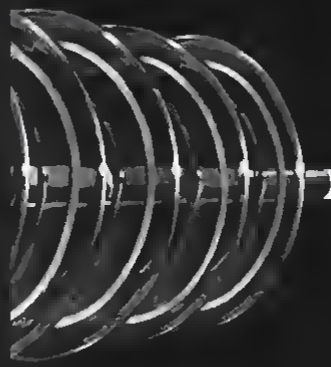
This is only one in a succession of missile programs for which General Precision's capabilities have been evaluated and found acceptable. Other areas where General Precision has demonstrated competence include Space Vehicle Guidance and Control, Manned Aircraft Systems and Sub-Systems, Air Traffic Control and Industrial Control. General Precision, Inc., Tarrytown, New York, the principal operating subsidiary of General Precision Equipment Corporation.



DIVISIONS:
GPL
KEARFOTT
LIBRASCOPE
LINK

GENERAL PRECISION

SPACE COMMUNICATIONS



MILLIONS OF CONVERSATIONS...

on a beam of light

A pencil of ruby light will slash across the vast continuum of space carrying millions of conversations on its solitary beam. Philco Research Scientists are busy today developing lasers for the next generation of communications systems . . . learning how to use the virtually unlimited information-carrying capacity of this unique device . . preparing to provide effective communications for space probes and manned vehicles coasting among the galaxies. Ruby lasers are typical of Philco's unceasing efforts to increase its leadership in all areas of communications for defense and industry.

PHILCO *Famous for Quality the World Over*

A SUBSIDIARY OF Ford Motor Company

Communications and Weapons Division • Communications Systems Division • Computer Division • Lansdale Division • Scientific Laboratory • Sierra Electronic Division • TechRep Division • Western Development Laboratories

Aviation Week and Space Technology

Volume 76
Number 11

March 12, 1962

TWENTY-NINTH ANNUAL INVENTORY OF AEROSPACE POWER

● COVER NASA Ranger 3 lunar probe on pad at Cape Canaveral

Aviation Week and Space Technology

Expanding Space Technology Spurs Aerospace Market Growth

Aerospace industry will climb to new peaks in gross sales and show increased earnings during 1962 with excellent prospects of maintaining these levels during the next three years. Gross sales for 1962 will top $15 billion.

Key to the new plateau of prosperity for the aerospace industry is the astonishing growth of space technology toward a $5 billion annual share of the over-all market, making it an equal partner with missiles and aircraft in the sales and technical spectrum.

Here is how the aerospace market looks for 1962:

- **$4.5 billion for space technology including** the National Aeronautics and Space Administration and the military space activities of the three services. NASA accounts for $3 billion and the military about $1.5 billion
- **$6 billion for military aircraft** including $3.7 billion for USAF, $2.7 billion for Navy, and $200 million for Army.
- **$4 billion for missiles** including $2.5 billion for USAF; $1 billion for Navy, and $500 million for Army.

Commercial aircraft sales will drop from the $2 billion annual level of the past two years because the bulk of new jet transports on order has been delivered to airlines, but this activity will account for another billion of the industry's sales in 1962.

Space technology will be the most fiercely competitive and significant portion of the aerospace market during 1962 as most of the major programs for the next five years take shape and develop their structure of supporting contractors. The prime-and-subcontractor pattern that is emerging on such major NASA programs as the Apollo manned lunar landing effort, the Saturn boosters, the liquid and solid Nova boosters and the communications satellite system will provide the significant clues as to where the major space business of the next three to five years will be going. Companies which fail to become part of these major programs during 1962 will face tough going in the space market in the years ahead.

Industry must keep a close watch on NASA's procurement policies and methods if it hopes to operate successfully in this area. This agency is new to large scale procurement effort and has not yet developed sufficient staff and experience to operate as well as military procurement agencies. In addition, the strong flavor of partisan politics and the use of NASA contracts to bolster the economy of the south and southwest will continue to produce some unexpected bounces of the contract ball as many key plums are dispensed directly from the NASA administrator's office, bypassing normal agency procedures.

There is a growing recognition of urgent military requirements in space that will result in a steadily expanding market over the next five years. Restrictions that kept military research and development in space technology operating at a relatively low level are slowly being lifted. An accelerated pace is indicated during 1962 and the years immediately after. Military systems are aimed at reconnaissance, early warning, communications and command and control functions, along with a generally expanding capability to use men in a wide variety of spacecraft activities. Defensive systems against enemy military space systems are also getting increasing emphasis.

Aircraft market will feel the stimulus of a number of new programs initiated during 1961 and early 1962. These include the C-141 strategic jet transport; the TFX bi-service tactical fighter program; the STOL tri-service transport, and the supersonic jet transport. However, biggest share of the future aircraft market will be the more than $1 billion now programed by USAF and Navy for the McDonnell F4H all-weather interceptor and tactical support aircraft. Commercial transport market will be dominated by the Boeing 727 short haul jet with increasingly stiff foreign competition from France and Britain over the whole civil aircraft range.

Missile market will be dominated by the two solid propellant weapons—the Navy's Polaris and USAF's Minuteman. Both of these weapon systems will achieve significant deployment during 1962. Growing interest in solid propellants will also spark new programs for military boosters such as the 120-inch diameter solid motors for use with Titan 2 to launch Dyna-Soar and other boosters ranging up to 240 inches in diameter. Future of the mobile medium range ballistic missile aimed primarily at NATO deployment is still uncertain. Main future market in the missile area will center about increasing capabilities in re-entry vehicles to overcome possibilities now looming for anti-ICBM defensive systems.

Avionics market is becoming increasingly competitive because of both economic and technical pressures. Vertical growth of established avionics firms is being accompanied by horizontal expansion of airframe and automotive firms into the avionics area. Developers of major avionics systems are now finding it more economical and advantageous in bidding on government contracts to broaden their capabilities to take on activities formerly done for them by suppliers.

At the same time, component manufacturers are expanding upward under the technical pressure of solid state technologies that enable whole circuits or subassemblies to be fabricated in place of individual components using earlier technologies.

Pace of mergers among avionics firms is accelerating but new organizations are still being created in the field, although at a rate well below the frantic expansion of the 1950s.

A large share of the rising space technology budget is devoted to avionics and depends on the continued ability of this portion of the industry to maintain its fantastic development of new technologies.

Use of the optical spectrum for guidance, communications and weaponry is typical of how expanded research and development creates new avionics markets. Microelectronics, self-learning machines and bionics are among the other significant technical trends aimed at improved reliability, greater capability and reduced costs in avionics systems.

Airlines should climb out of their dismal slump in 1961 to a slight over-all industry profit for 1962. Improving prospects are based on a rising traffic curve and a downward curve in the tremendous transitional costs of re-equipping their fleets with jet transports. Traffic growth shows signs of resuming a healthy trend in 1962 after two years of virtual stagnation.

Carriers are still faced with the unsolved problem of overcapacity and a declining load factor with no indications of a solution ahead. Few airlines have shown much ingenuity in revising their sales and marketing techniques to broaden the air travel market despite signs that the traveling public responds sharply to any attempts to increase convenience and reduce fares. The Eastern Air Lines air shuttle services are good examples of this.

Technical and economic impact of jet transports will continue to change the basic character of airlines, creating fewer and larger trunk carriers and expanding local service carriers to the size and scope of regional airlines. Local service airlines face the possibility of competition from below by creation of a third class of carrier using small executive type transports to expand air taxi service into scheduled service at smaller cities where traffic generation is not sufficient to support unsubsidized local service carrier operations. Supplemental air carriers will face a tough future with increased scrutiny of their operations by Congress and the Federal Aviation Agency.

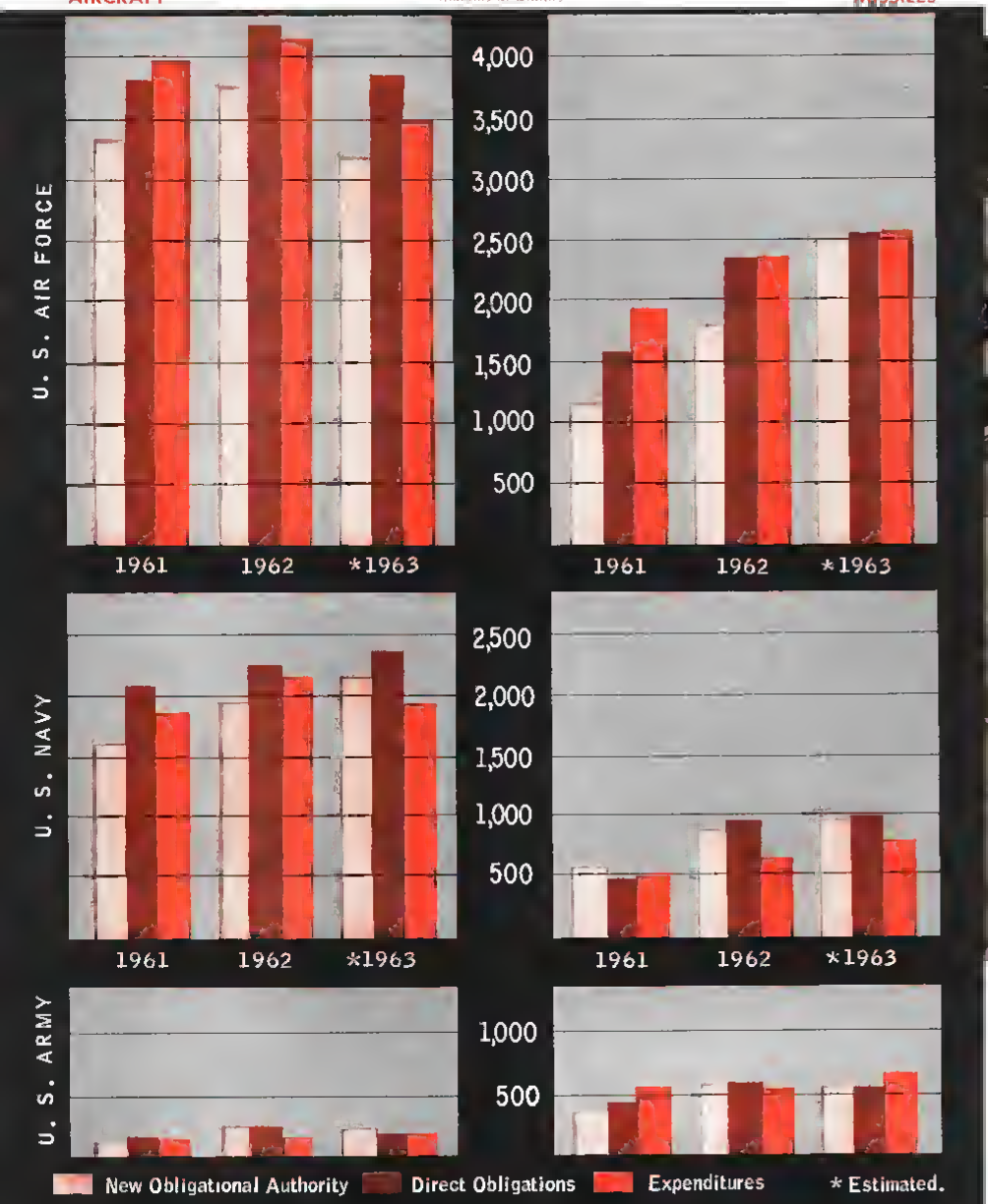
Business flying will rebound from its minor recession of 1961 with a gross sales volume that may equal the $200 million high-water mark of 1960. Excess inventories of new and used aircraft that bampered 1961 sales efforts have been greatly reduced. Manufacturers' retail outlets entered 1962 with a considerably expanded line of models as a result of record retooling and development within the industry to shape its products to customer demands. Export sales volume will show continued steady gains, with a 20% increase predicted over the 1961 record sales of $30 million in international markets.

The $15 billion sales plateau facing the aerospace industry for the next few years is based on two major decisions made by President John F. Kennedy last year. They are:

- **Enter the space race with the USSR** with a full scale effort aimed at attaining international leadership in this field for the U. S.
- **Increase the U. S. military capability** for handling all varieties of limited wars while maintaining a steady high level of nuclear deterrent forces.

Both of these programs require a level of expenditures over the next five years at the same high levels as 1962 and must be sustained by a heavy research and development effort. Thus it appears that the aerospace industry's economic foundations are now on a more stable footing than they have been for several years and at the same time that the research demands on the industry will range farther across the technical spectrum than ever before. —Robert Hotz

Major Military Obligations and Expenditures



CONVAIR B-58 crew of the Strategic Air Command 43rd Bombardment Wing, Carswell AFB, Tex., races for its airplane in a simulated alert

Military

STORES CARRIED by the McDonnell F4H, which DOD ordered USAF to buy as the F110, include four Sidewinder (on wing racks) and four Sparrow 3 air-to-air missiles, wing mounted fuel tanks and a bomb mounted on the belly.

DOD Widens Control, Reshapes Services

By Larry Booda

Defense Department is exercising a greater degree of centralized, civilian control of the military services than it has since its creation, all with the strong backing of the Kennedy Administration.

Ramifications of this shift, carried out under Robert S. McNamara, appointed as Secretary of Defense by President Kennedy 14 months ago, affect not only the services but also the industry which does business with them.

Major trends in the Department of Defense-service relationships can be grouped under:

- **Extensive reorganization** within the services and in some of Defense Department's methods and structure as well.
- **Shift to DOD** of what had been prerogatives of the individual service in determining weapon system requirements and selection of contractors for major systems.

McNamara's motives for many of these moves have been ascribed to his insistence that the individual military services eliminate service competition for defense budget dollars by considering overall defense needs in originating and continuing weapon systems and requesting funds for them. He has canceled or slowed some programs and accelerated others.

Most of the decisions have been based on crash evaluations undertaken by groups within the Defense Department. These analyses are based on what are called program packages that group similar forces together and then project each weapon system for five or more years into the future. This enables a searching scrutiny from a cost-effectiveness standpoint.

Package Divisions

Program packages as they now stand are the General War Forces, the General War Defensive Forces, the General Purpose Forces, the Sealift and Airlift, Reserve and National Guard Forces, Research and Development and Service-Wide Support (AW Dec. 25, p. 14).

In testimony before House and Senate committees this year regarding the Fiscal 1963 budget, McNamara underscored this breakdown by discussing programs and forces, not the military services.

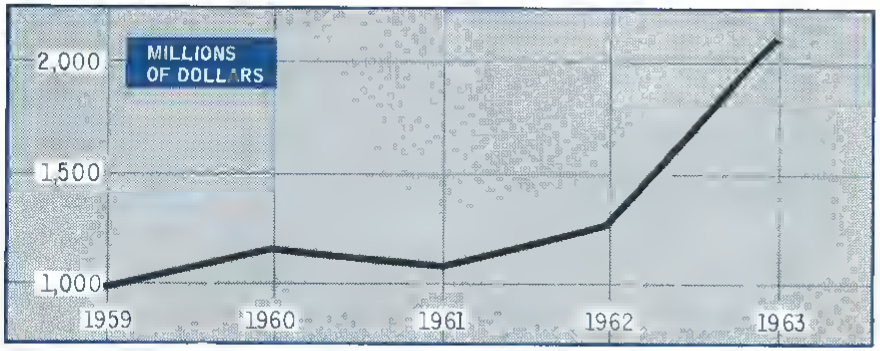
In its final form the defense budget request for Fiscal 1963 was for $51.6 billion in new obligational authority. This is $3 billion more than the Fiscal 1962 budget submitted by President Eisenhower and $3 billion higher than the Fiscal 1962 budget as amended by Kennedy.

In essence, the Fiscal 1963 budget maintains nuclear retaliatory capability with approximately level funding but emphasizes the buildup of forces to wage wars of less than nuclear or general non-nuclear war intensity. The bulk of the increase would go to the Army's strategic forces and the Air Force's airlift.

With the Secretary of Defense stepping into inter- and intra-service affairs, workload devolving on the various assistant secretaries of defense and the director of Defense Research and Engineering has increased. In many instances the offices were not staffed with the quality or quantity of personnel who could conduct studies, evaluate others and afterward make sound recommendations.

They were thrust into an atmosphere of "immediate, if not sooner" action. Replies were directed to be made in hours or days. Contract award dates were announced in advance.

The staff of the Joint Chiefs of Staff,



INCREASE IN FUNDING for the Office of the Secretary of Defense reflects its growing role in military affairs

900 civilians and military personnel, which had in the past taken extended periods of time to research and debate studies exhaustively, found itself ordered to produce recommendations in days instead of months. As a result it floundered badly in the early days of the McNamara regime but has since adjusted to the increased tempo. This applies as well to the services, which by now have become accustomed to quick decisions.

Two men in the Office of the Secretary of Defense have emerged with powerful voices in determining force structures and characteristics of weapon systems. They are Assistant Secretary of Defense (Comptroller) Charles J. Hitch and Dr. Harold Brown, director of Defense Research and Engineering.

Dr. Brown, who ranks third in the Pentagon hierarchy after McNamara and Deputy Secretary of Defense Roswell Gilpatric but ahead of all the assistant secretaries of defense, heads an organization which has found itself thrust into making final determinations on feasibility studies on new systems, evaluating technical worth of weapon systems and even dabbling in project management.

Dr. Brown has three deputies, one of whom, Dr. John H. Rubel, has the title of assistant secretary of defense (deputy director) of Defense Research and Engineering. There is a deputy director (research), Dr. Eugene G. Fubini, and a deputy director (weapon systems), Dr. Marvin Stern. Dr. Brown's office also includes the Advanced Research Projects Agency and the Weapons Systems Evaluation Group. Reflecting its increasing importance, it has been reorganized twice since the Kennedy Administration took office. Defense sources say that it will soon be reorganized again.

Traditionally, the services determine their own requirements for weapons systems that would fulfill their missions, but Defense Research and Engineering has stepped into this area. On the grounds that it would avoid confusion and duplication, all service weapon requirements are now reviewed in Dr. Brown's group for technical worth and by Hitch's organization for cost effectiveness.

Dr. Brown's tasks have gone beyond determinations of technical merit. Contractor competence determinations have been made, Defense sources said, to make sure that the services were not playing favorites.

One example of the influence of Defense Research and Engineering in determining the character of a weapon system is the TFX tri-service tactical fighter. Early last year McNamara announced that the tactical fighter requirements of all the services would be combined into one aircraft that would be able to perform close support, air superiority, reconnaissance and interdiction missions.

In the arbitration, mediation and recrimination that has followed, the TFX tri-service fighter has become the VAX close support aircraft and the TFX fighter with Air Force and Navy versions. Defense Research and Engineering determined the feasibility and practicability of the TFX, recommended finalists in the competition, and will influence choice of a contractor.

The activities of Hitch are less direct, but they have a greater long-term influence. The program package concept, or the stern look at cost and effectiveness of a weapon system over its entire lifetime, can be credited to him.

For the period immediately following the inauguration of President Kennedy, Hitch was preoccupied with changes in the Eisenhower defense budget. But by March, 1961, he began to introduce the program packaging system, ordering the services to produce five-year cost projections for every weapon system, and, in addition, less specific estimates through 1970. Deadline for service submissions was July.

The program package studies delayed the normal budget processes of the military services because it took all summer for the Hitch staff to prepare budget guidelines based on the packages to use in the preparation of their fiscal 1963 budget requests in legal form.

From Oct. 23 until the middle of December, McNamara personally reviewed the service requests, sending 600 memoranda, privately referred to as his "snowflakes," directing changes in submissions.

In directing revisions, McNamara and Hitch based them on program package guidelines. Program packages are a group of interrelated program elements that must be considered together because they support each other or substitute for each other. A program element is a combination of men, equipment and installations that forms an integrated activity.

As a result of cost effectiveness studies of current weapon systems and reviews of weapon systems projected in the future, McNamara has wielded a heavy hand in discontinuing procurements and shifting emphasis.

He canceled the nuclear powered aircraft program, the Navy's Missileer subsonic fighter and the Eagle long range air-to-air missile it would have carried, and the Mobile Minuteman solid propellant intercontinental ballistic missile which would have been deployed aboard railroad trains.

He has resisted attempts by Congress to force him to accept more money for continued production of heavy bombers. He has blocked the Air Force from expanding its B-70 Mach 3 bomber project beyond a program calling for three flyable aircraft, one of which would contain a bomb navigation system.

For the second year, he withheld funds for long lead time production items for the Army's Nike Zeus anti-missile missile system. A production decision awaits further development tests of the Zeus against Atlas missile warheads in the Pacific beginning this summer.

An anomaly that has appeared in the broadened organizations of Dr. Brown and Hitch is that they have had to invade the specialty area of each other. For example, Defense Research and Engineering, to support its positions, now has to append economic studies to its technical analyses and recommendations, making employment of economists necessary. The comptroller's organization, on the other hand, found itself faced with the necessity of making scientific judgments in analyzing program packages, so scientists and engineers are needed there.

Political Considerations

Added to technical and cost effectiveness recommendations are political considerations. Pressures resulting from economic stress in depressed areas are reflected through the White House to the Defense Department, placing another term in the decision equation.

Until last summer McNamara tended to bypass the Joint Chiefs of Staff in many actions. Indications are now that he has better relations with the Joint Chiefs as a whole.

There were some attempts early in the Kennedy Administration's tenure to usurp some of the operational prerogatives of the Joint Chiefs. The notable example was in the case of the ill-fated Cuban invasion when the Joint Chiefs were called in too late to provide well planned support. What support they did have standing by was hemmed in by policy restrictions that made the support ineffective.

Traditional service structures have been drastically altered by McNamara. Leading the parade was the Air Force, whose stake in weapon systems requiring concurrent research, development and production is greater than the Navy or the Army. From the Air Research and Development Command, which dates from 1950, and the Air Materiel Command which dates back to the days of the Army Air Corps, the Air Force Systems Command was formed to eliminate areas of responsibility that overlapped. In this instance, the Air Force was ready to place all applied research, development, test, evaluation and procurement under one command, and needed only high level encouragement.

Tradition was upset more in the Army than in any other service. Of its nine technical and administrative services, four dated from 1775. All had their own research and development and procurement organizations. Some of these were abolished, some had their status changed and all development and procurement was placed under a new Materiel Development and Logistics Command whose functions will resemble those of the Air Force Systems and Logistics Command combined. In USAF, Logistics Command supports weapons systems after they become operational.

Most recently affected was the Navy, but in milder fashion. Each of the Navy's bureaus, such as the Bureau of Weapons and the Bureau of Ships, has responsibility for its own applied research and development programs and procurement which follows. The chiefs of those bureaus report directly to the Secretary of the Navy. Development coordination has been the responsibility of the Deputy Chief of Naval Operations (Development). A new directive makes DCNO (Development) responsible to the Secretary of the Navy as well as to the Chief of Naval Operations. Informed sources indicate that this step is only preparatory to overhaul of the Navy's whole bureau structure.

McNamara has accomplished unification of many activities in the Defense Department by executive order rather than by changes in law. He has created the Defense Intelligence Agency, Defense Supply Agency and the Defense Communications Agency. A Defense Atomic Support Agency was already in existence.

Combat forces have been affected, too. The Air Force Tactical Air Command and the Army's Strategic Army Command were combined to form the U.S. Strike Command.

Defense planners are considering other unification moves, paralleling program packages. These would be a Strategic Command, a Continental Defense Command, a Sea Defense Command, a Supply and Support Command and a Research and Development Command.

USAF MINUTEMAN is lowered into silo at Cape Canaveral for test shot

● USAF

USAF Wins Space Role Support; Overruled

Air Force is winning reluctant recognition of a broadening military mission in space, but is finding itself overruled by Defense Department strategists and economists on the weapon system requirements—both type and number—for maintaining a nuclear deterrent.

Two basic Administration or Defense Department policies are colliding in some cases with USAF's own estimates. One is a decision that U.S. nuclear war capability is adequate but that non-nuclear forces are not and need priority for strengthening. The other is the program package concept, from which sprouted the goal of multi service standardized aircraft.

The specific results:

- **Minuteman production** and long lead time item procurement was reduced below Air Force requests, and mobile Minuteman was killed.
- **Bomber production** funds voted by Congress, either for the Convair B-58 or Boeing B-52, were impounded by Defense Secretary Robert McNamara.
- **Development of the North American** B-70 into a complete weapon system was rejected by DOD which is holding the program to three flyable aircraft, one with a bombing-navigation system.
- **Republic F-105** single engine tactical fighter procurement was ordered cut and Air Force instructed to buy the McDonnell F-4H Phantom 2, developed for the Navy under the designation F-110.
- **Development of the TFX** tactical fighter, proposed by Air Force was turned into a multi service project.

Air Force has felt the grip of Secretary McNamara in directing activities to a greater extent than any other service. Besides changes in programs, it has been assigned missions it regards of debatable value. Its share of the defense budget has been cut from 43 to 38%.

Little reaction was heard from the Air Force until congressional hearings began on the defense budget late last month. Then Secretary of the Air Force Eugene Zuckert, and the chief of staff, Gen. Curtis E. LeMay, made it unmistakably clear that they did not share McNamara's views on the sufficiency of nuclear deterrent power.

Gen. LeMay, in stressing what he believes is a continuing manned bomber requirement, said that at this late date the B-52 production line at Boeing Wichita could be continued in action only at great expense as activity there has already slowed. He advocated development of the B-70 as a complete weapon system with a reoriented mission, that of strike-reconnaissance designating the aircraft the RS-70.

Nor was LeMay satisfied with the DOD Minuteman program. Fiscal 1963 budget requests provide for 200 more of the solid-propellant silo-based intercontinental ballistic missiles, making a total of 800. LeMay would increase this by another 100 missiles and authorize production of long lead time items for another 150.

Cost of Mobility

McNamara canceled the mobile, truck-mounted Minuteman with the explanation that the technical problems the concept presented were not worth the extra cost required and that ballistic missile mobility was furnished by the Navy's Polaris submarine-fired missile.

He also excised requests for all small transport type aircraft. However, there are indications that he may relent to the extent that orders will be permitted in limited quantity to keep production lines operating.

Another McNamara order calls on the Air Force to proceed with a solid propellant mobile mid-range ballistic missile (MMRBM). This truck-mounted weapon is intended principally for use of NATO countries. Its range would extend from 200 to 2,200 mi., filling the range between the Army's Pershing tactical missile and the ICBMs. It would eventually replace the Thor and Jupiter liquid-propellant intermediate range ballistic missiles now deployed in Europe. Requirements have also been included which would make it capable of being fired from ships and barges.

There are doubts that the MMRBM will ever become operational because of political considerations. Not the least of them is whether Congress will permit control of nuclear weapons to be given other countries. France, for example, insists on full control of such a weapon.

In the field of space, on the other hand, Air Force appeared to be winning Defense Department approval for some of its more advanced ideas. An indication of this was clearance by the Office of the Secretary of Defense of a comprehensive statement on Air Force's space plans made before the House Armed Services Committee last month by Lt. Gen. James Ferguson, USAF deputy chief of staff for research and technology.

Air Force Aircraft on Order

AIRCRAFT TYPE	POPULAR NAME	MANUFACTURER
B-58	Hustler	Convair
B-52H	Stratofortress	Boeing
B-70	Valkyrie	North American
F-105D	Thunderchief	Republic
F-110 & RF-110	Phantom 2	McDonnell
T-38	Talon	Northrop
T-39	Sabreliner	North American
L-28	Helio Courier	Helio Aircraft
H-43B	Huskie	Kaman
C-130B, C-130E	Hercules	Lockheed
C-135B		Boeing
KC-135	Stratotanker	Boeing
C-140	JetStar	Lockheed
C-141		Lockheed

Air Force Missiles and Space Vehicles on Order

MISSILE or VEHICLE	MISSION	MANUFACTURER
Minuteman	ICBM	Boeing
Atlas	ICBM	Convair
Titan	ICBM	Martin
Hound Dog	Air-to-Surface	North American
Thor	Space Booster	Douglas
Skybolt	Air-to-Surface (Ballistic)	Douglas
Bullpup	Air-to-Surface (Close support)	Martin
Sidewinder	Air-to-Air	Philco
Falcon	Air-to-Air	Hughes
Bomarc B	Surface-to-Air	Boeing
Atlas D	Space Booster	General Dynamics
Agena A, B and D	Upper stage space vehicle	Lockheed
	Discoverer, Midas & Samos projects	

● USAF

On Deterrent

U.S. national policy, he said, recognizes four reasons for conducting projects in space: to increase scientific knowledge, to exploit commercial applications, to strengthen military capabilities and to enhance national prestige.

The prime objective of the Air Force, he said, is to exploit space so as to retain U.S. military superiority in order to ensure the peaceful use of space. Space systems must be considered with all other systems and will be developed only when they offer the only means, or the best means for performing a specific mission.

In the next five to seven years, Gen. Ferguson said, a number of early military applications are feasible which offer better ways of doing things.

These include geodetic mapping, warning of ballistic missile attack, aiding surface navigation, meteorological surveillance and communications all by satellite.

Space Projects

The projects referred to are Anna, which is an Air Force, NASA, Navy and Army geodetic satellite under cognizance of the Army; Midas infrared sensing satellite to spot ballistic missiles in their powered phase, the Navy's Transit navigation satellite and an unnamed military weather satellite, and CSAR, which stands for Communications Satellite, Advanced Research. Though not included by mission in this list, Air Force also is developing Samos a photographic reconnaissance satellite which has a top national priority. The project director reports directly to the Secretary of the Air Force.

Although talked about openly until about a year ago, the project is now cloaked in secrecy. Whether it has gleaned information of value, superseding U-2 aircraft reconnaissance has not been revealed.

As applications farther in the future, Ferguson listed improved systems for attack warning, detection of nuclear testing, surveillance of unidentified satellites, defense against ballistic missile attack by interception during earlier phases of flight, space-based command and control systems, logistics (including space based maintenance and repair), solar flare warning, training and rescue.

Rendezvous in a hostile environment is a military requirement, Ferguson said, pointing out that the lunar landing program involves rendezvous with a friendly satellite. Factors such as cost, dependability, reusability, quick reaction, positive control, security and combat environment have different implications for military missions than they

AIR FORCE THUNDERBIRDS MANEUVER F-100S ABOVE B-52H

have for scientific, commercial or prestige applications he said

"Can man effectively perform specific military combat functions in space?" was one question posed by Ferguson The Air Force, he said is well equipped in the science of bioastronautics to follow the logical steps to see whether man can live in the space environment for protracted periods

NASA's Mercury program and the successful three orbit flight of Lt. Col John Glenn, Jr., already has indicated the answer to this question will be a resounding, "yes"

Air Force support of NASA space programs increased in scope and size in the past year Most of NASA's launching requirements dictate the use of the Atlantic Missile Range facilities at Cape Canaveral and world-wide tracking networks

Until recently, NASA requirements have been taken care of through more than 50 separate agreements It became apparent that a formal organization would be necessary to administer the greatly expanded NASA space program which was proposed by President Kennedy and endorsed by Congress Tremendous expansion of facilities at Cape Canaveral and elsewhere will be needed to support the moon landing program

In order to meet the situation the Defense Department has proposed that a liaison office with NASA be established, with the Air Force acting as the executive agent This organization would have control of all activities which would be needed by NASA, in all of the services, from flight physical examinations for astronauts to life sciences research and development, furnishing of boosters, communications, sea and air recovery forces and bailment of aircraft This agreement is expected to take effect this spring No determination has been made as to who would be the NASA and Defense Department senior personnel in the organization

Organization of the Systems Command from elements of the Air Research and Development Command and the Air Materiel Command laid great stress on space since it included a newly created Space Systems Division among other things Nevertheless its creation also recognized other highly significant changes affecting the future of the Air Force

R&D Growth

In the research, development test and evaluation environment which exists in the Air Force today, the complexities of weapon systems and the necessity of making them operational in as short a time period as possible had outgrown the Air Force command structure in this area

Until last April basic research and development were the responsibilities of the Air Research and Development Command, with headquarters at Andrews AFB, Md

Procurement test and evaluation came under the Air Materiel Command at Wright Patterson AFB, Dayton, Ohio

With the increase in missile system development, the concept of concurrent production was introduced Overlap of responsibilities developed between the two commands A gray area existed in each system because of the ill defined point at which command responsibility was shifted from ARDC to AMC

Outcome was creation of the Systems Command with responsibility for a weapon system from its inception to its operational deployment At that point the new Air Force Logistics Command would assume the support role. Representatives from every element in the Air Force or other services or agencies interested in a project are part of each system office The System Program Offices in the four principal divisions of Systems Command have as their heads System Program Directors, each one of whom is responsible for his system until it is operationally deployed

Systems Command spends $7.5 billion per year The old ARDC and now AFSC have had such phenomenal growth that radical changes in the manner of doing business have had to be made New control and management techniques are being introduced For example, each designated system is now managed, or will soon be managed by use of the PERT system

Booster Programs

Air Force space ambitions and technological advances in aircraft and missiles have produced a search for new vehicle and booster concepts, but in some cases these have resulted in lack of agreement with Defense Department

One such case is the Dyna Soar orbital bomber As it had for the B-70, Congress also had voted extra funds for acceleration of Dyna-Soar that the Defense Department refused to spend DOD maintained that there was enough money in the 1962 budget to carry the Dyna-Soar program at a satisfactory level

Air Force programs are intimately tied to booster technology in which simplicity and low cost are desirable to permit launchings to become routine

First step beyond the present Atlas D and the soon-to-come Titan 2 is the Titan 3 This would combine the Titan 2 with two 120-in dia solid propellant segmented motors strapped to it, acting as a first stage This would provide for placing about 3,500 lb into a synchronous equatorial orbit or 8,000 lb into an escape trajectory if the upper stage were an Agena D vehicle.

Titan 3 isn't seen as the ultimate launch vehicle Recommendations have been made that a 156-in dia solid propellant booster be made the workhorse vehicle for the Air Force This was envisioned by the Air Force Phoenix concept

Typical of the dependence of advanced space concepts on boosters is Dyna Soar Originally the boost-glide vehicle was scheduled to be launched initially into ballistic trajectories, and subsequently Titan 2 would boost the 15,000-17,000 lb glider into orbit When this turned out to be unfeasible, the Saturn S-1 was proposed as booster Now it has been determined that the Titan 3 combination will be used, skipping the ballistic flight phase and going directly to orbital flights.

This program had undergone so many reorientations that Secretary of Defense McNamara personally visited the prime contractor to make a final determination

Aerospace Plane

Only recently has the Air Force acknowledged the existence of the Aerospace Plane concept, which would entail going a step beyond Dyna-Soar Unlike Dyna-Soar, Aerospace Plane would be powered Its propulsion would be liquid oxygen-liquid hydrogen engines.

Able to take off from a standard airfield. Aerospace Plane would climb with a full load of liquid hydrogen but only enough oxygen to get it into orbital flight in the outer atmosphere, at about 300,000 ft altitude At this altitude it would scoop in air, compress and liquefy it, separate the nitrogen from the oxygen and store the liquid oxygen Since it takes eight times the amount of liquid oxygen as liquid hydrogen by weight for their chemical combination the concept would provide for a takeoff weight of 500,000 lb but a full load weight at altitude of 1,000,000 lb

Aerospace Plane is beyond the feasibility study stage and advanced research has started on some components Whether the concept is practical still has to be determined

Aerospace Plane represents an alternate means of achieving orbit and escape from the earth with a maneuverable vehicle

Air Defense also took cognizance of the growing importance of space North American Defense Command will move into its combat operations center underground in Cheyenne Mountain, Colorado Springs Colo., in 1963. Not only will this center control air defense forces to meet attacking aircraft, but it will also have a capability for detecting ballistic missiles and spacecraft Eventually it will have control of what defense space systems the U.S. develops

In the realm of weaponry more immediately at hand, Air Force is concentrating on building its operational intercontinental ballistic missile inventory and extending the capabilities of its B-52 heavy bomber wings

Missile Status

Status of these programs

- **Atlas deployment,** including Atlas F silo missiles, will be completed this year A complete ICBM wing is operational at Warren AFB, Wyo., the first Air Force operational establishment exclusively devoted to missiles and its deployment marks completion of site activations for the Atlas E coffin site version
- **Titan 1,** silo fired missile will become operational this spring Emplacement of Titan 1 will continue through 1963
- **Titan 2,** a storable propellant version of Titan 1, will begin development firings at Cape Canaveral soon USAF plans a limited production run of Titan 2 as an ICBM, but it will have further application as a space booster
- **Minuteman** solid-propellant ICBM is scheduled to become operational late this year Minuteman with its solid propellant simplicity, will be the most economical missile in the U.S. inventory USAF says its unit cost, in production quantities, will be $5 million
- **Skybolt air launched ballistic missile** development was accelerated last year when greatly increased Russian air defense capabilities became apparent at the Tushino air show (see page 27) and AW July 17, p. 26, AW July 24, p. 26).

As a weapon for the turbofan powered B-52H, Skybolt is designed as a penetration missile with a range of over 1,000 mi Until this long range capability to prolong the usefulness of the B-52 became essential, the program had foundered through lack of agreement within the Air Force and consequent lack and interest and funding support from the Defense Department

Then a brigadier general was placed in charge of the system development, size of the system office at Aeronautical Systems Division, Wright-Patterson AFB, was increased and a subdivision of this office was established at the plant of the contractor, Douglas Aircraft Corp., Santa Monica Calif Most Skybolt testing will take place at the Eglin Air Proving Ground Center Firings will be made down the Atlantic Missile Range

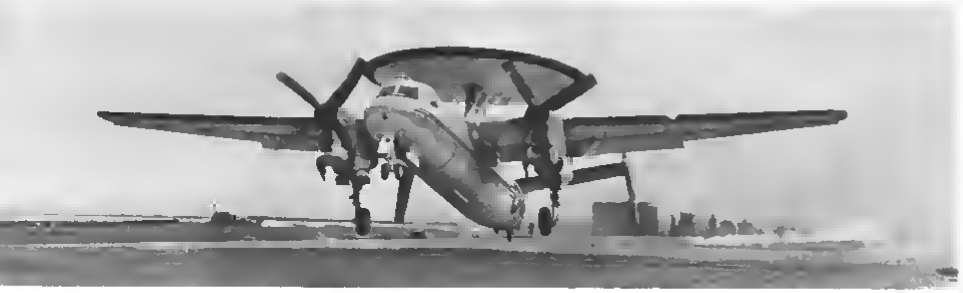
Air Force Active Aircraft Inventory

(End of Fiscal Year)

1958	22,578
1959	20,890
1960	18,712
1961	16,905
1962 (Planned)	16,244
1963 (Planned)	15,449

TITAN 2 ENGINE STATIC TEST FIRING

B-52H WITH LATEST CONFIGURATION SKYBOLT MISSILES



GRUMMAN W2F-1 HAWKEYE IN CATAPULT TESTS

Navy Reacts to Soviet Undersea Challenge

Navy entered 1962 with an increased anti-submarine warfare effort, meeting a growing congressional controversy over its request for a new aircraft carrier, and expanding the Polaris submarine-fired missile program to meet goals that have been more than doubled.

These actions stemmed from the threat of a growing force of Russian missile-firing submarines, a need to replace aging carriers whose principal mission is in support of limited war actions, and enthusiastic Administration approval of the role Polaris is playing as part of the nation's nuclear deterrent force. Because of the versatility of the Navy-developed McDonnell F4H twin-engine fighter, USAF will buy this model in greater numbers than Navy in Fiscal 1963.

Navy's ventures into space were modest but relatively successful, with the Transit navigation satellite development launches providing increased knowledge of the earth's shape as an aid to map-makers. Its operation of the Pacific Missile Range was marked by growing activity with firings of the operational configurations of the Air Force's ballistic missiles becoming routine and preparations for tests of the Army's Nike Zeus anti-missile missiles nearing completion.

With the growing threat to the U.S. mainland of Soviet missile-firing submarines, a major anti-submarine warfare program has been initiated.

It is estimated that there are now 25 C- and Z-Russian class submarines equipped with relatively short ranged—about 350 mi.—weapons which must be fired from the surface of the ocean. These submarines are conventionally powered with diesel engines and batteries. They can recharge their batteries in a submerged position by drawing air through a snorkel.

Latest intelligence estimates place the number of Russian nuclear-powered submarines at five, two more than last spring. There is no indication that these submarines have the ability to fire missiles from a submerged position.

Navy has been faced with maintaining an increased alert with its deployed forces overseas. When the political and military situation in Laos became critical, an extra attack aircraft carrier and additional Marines were sent to the western Pacific. An additional attack carrier has been added to the Sixth Fleet in the Mediterranean.

Early in 1961 the Marine Corps was preparing to reduce its strength to 172,000. This reduction was canceled by President Kennedy and a buildup to 190,000 ordered. Sufficient additional aircraft for a third full Marine Air Wing was also ordered, to match the ground force increase.

Because of a budget request for Fiscal 1963 slightly smaller than Fiscal 1962, the Navy has had to adjust to the increased Polaris program by a cutback of shore installations and the larger surface ships in the non-carrier category. Despite a decreasing aircraft inventory, the operational costs have increased due to more complex aircraft entering service.

From a target of 19 of the nuclear-powered Polaris submarines each carrying 16 missiles at the beginning of 1961, the request is now for 41. Of this number 29 have already been authorized and are under construction; six more are requested in Fiscal 1963 and procurement of long lead time items for another six also is asked.

Six submarines already are deployed, another three are due before the end of the year, making 144 missiles available on station most of the time.

The first six submarines are fitted to take only the A1 version of the Polaris, which has a range of 1,200 naut. mi. Subsequent boats are fitted with longer firing tubes to accommodate the A2 version which has a range extended to 1,500 naut. mi. This is accomplished by adding more propellant in a power section which is 30 in. longer than the A1. Each of the first six submarines will be converted to take the A2.

A follow-on version of the missile is being developed which will have a range of 2,300-2,500 naut. mi. or will carry a heavier warhead shorter distances.

The A3 missile will gain its added range by using a new fuel, a nitroplasticized, double-base solid propellant which is denser than the composite polyurethane fuel used in the A1 and A2. Elasticity of the new fuel will permit the use of less binding material, resulting in a denser propellant. A nitroglycerin-like compound, with aluminum powder added, and ammonium perchlorate oxidizer is mixed with the nitrocellulose binder. This mixture burns about 1,000F. hotter than the mixtures in the A1 and A2.

An expanding debate is being waged within the Navy as to the worth of aircraft carriers 10 years from now and subsequent to that time. There is little argument about the worth of the carriers in limited types of wars in furnishing troop support in out-of-the-way places and some nuclear capability in an all-out war. But long-range planners must take into account new methods of locating and identifying ships at sea and new ways of destroying them. Ten years from now the Russian submarine fleet could be completely nuclear powered, posing a threat to ships at sea and capable of firing missiles against targets ashore in the manner of the Polaris.

Navy request for a new conventionally powered carrier promises to become a controversial issue during the current session of Congress. A number of congressmen have already stated that they will not approve construction of any large Navy ship that is not nuclear powered. Since nuclear power adds about $100 million to the cost of a carrier, this point is expected to be exploited by opponents of the carrier to kill the request altogether.

In the next four years the variety of aircraft used by the Navy on its attack and anti-submarine carriers and at land bases will shrink. This will be especially noticeable in the case of the attack carriers.

The shift to all turbine-powered aircraft has not yet been accomplished in this category. There are still many propeller driven Douglas AD series planes deployed for use as heavy, load-carrying, close-support vehicles which can remain on station for a long period of time. They are especially suitable for support of guerrilla troops. As field anti-aircraft weapons are improved by the Communist bloc nations, however, propeller-driven aircraft will have less chance of survival. The ADs will disappear from the fleet and from the Marine squadrons in another two years.

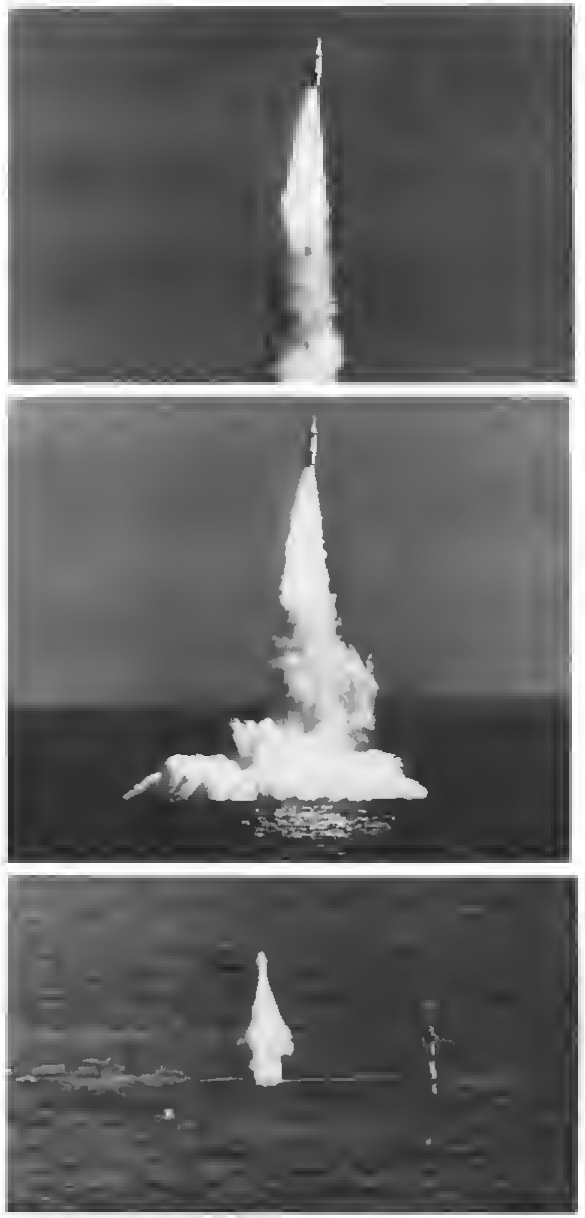
In the support role, the AD is being replaced by two aircraft, the Douglas A4D series and the Grumman A2F-1. A4Ds are now in use by the Navy and Marines in quantity. One model, the A4D-2N, has an all weather capability. The A4D is lacking in endurance, making necessary almost immediate accomplishment of the mission after reaching the scene of action. It has good load-carrying ability and can fly slow enough for accuracy in hitting comparatively small targets.

A2F Phase-in

The A2F-1 is a twin-jet aircraft designed for great load carrying ability, range and endurance and the ability to carry out its mission in all types of weather. It is being phased into the fleet now and will be produced for the next three or four years.

All Navy fighter aircraft have some capability in close-support work in addition to air superiority. The most recent fighter addition is the McDonnell F4H-1 twin jet, two-place fighter, which has proved so successful that the Navy is buying them in quantity as eventual replacements for the McDonnell F3H, the Douglas F4D and the Chance Vought F8U. The F4H is a Mach 2.3 aircraft and the F8U is also supersonic. The F4D is a transonic aircraft.

As a follow-on to the F4H, the Navy is participating in the TFX tactical fighter program which was ordered by Secretary of Defense Robert S. McNamara in February, 1961, originally as a tri-service program to produce an aircraft which would be capable of close



POLARIS A2 UNDERSEA LAUNCH

CHANCE VOUGHT F8U-2NE prepares for catapult from the nuclear powered carrier Enterprise. Distinctive island structure mounts a variety of avionic equipment

support, air superiority, interdiction and reconnaissance missions

Another type of propeller driven aircraft operates from the attack carriers, the airborne long range radar tracking Grumman WF-2, an adaptation of the ASW S2F series. It carries an "umbrella" antenna overhead. It is due to be superseded by the Grumman W2F-1 which is turboprop-powered.

Aim of the airborne radar stations is to feed information into the Air Tactical Data Simulator (ATDS) a semi-automatic system for control of intercept and attack aircraft, which in turn feeds into the fleet's overall Naval Tactical Data System (NTDS).

Navy's heaviest punch from carriers comes from two twin-jet aircraft. The Douglas A3D is widely deployed and has been operational for some time. Its planned successor is the supersonic North American A3J. Development of the A3J as a weapon system has not yet been completed although the aircraft itself has demonstrated carrier-operating ability.

Navy Active Aircraft Inventory

(End of Fiscal Year)

1958	10,553
1959	9,649
1960	8,863
1961	8,793
1962 (Planned)	9,297
1963 (Planned)	8,950

In carrier-based anti-submarine warfare the Grumman S2F series of aircraft forms the backbone of the effort and is aided in pinpointing submarines by the Sikorsky HSS-1 and HSS-2 helicopters. The HSS-2 is powered by two turboshaft engines. Participating in the air effort are shore-based Lockheed P2V series aircraft and Martin P5M seaplanes. Last deliveries of the P2V-7 were made in 1961 completing a production run of 15 years. Successor to the P2V will be the Lockheed P3V-1, a four turboprop landplane conversion of the Electra commercial transport. It will join the fleet late this year.

Another approach to airborne ASW is the drone anti-submarine helicopter (DASH) which is designed to operate from platforms on the sterns of destroyers. Reason for an unpiloted aircraft is to deliver a Lulu anti-submarine nuclear weapon without having to avoid destruction itself in dropping the weapon.

Guidance difficulties have jeopardized the program, however, and there are plans to use manned aircraft for an interim period in this type of operation. Tactics would be altered to avoid unfavorable results from an underwater nuclear blast.

Navy's current ASW effort has been the target of criticism because of the growth of the Soviet fleet of missile-firing submarines. At present the forces combine anti-submarine submarines, surface ships carrying variety of detection systems and attack weapons, airborne detection and attack systems, and fixed passive and active underwater detection systems. These fixed systems take advantage of the fact that a shallow continental shelf extends from the East Coast of North America for hundreds of miles, making seabed installations possible. All standard detection systems now in operation depend on conduction of sound waves in water.

Currently, a six-month study effort is being made by a team of 30 officers and civilians to assess just how the changing submarine threat should be met. New state-of-the-art detection methods are being considered for inclusion in the ships and aircraft. Organization of the forces in getting a close look.

Possibilities for breakthroughs exist in the infrared detection of submarines which leave slightly warmer water in their wakes than the surrounding water as do all surface ships. Their wakes also make possible phosphorescent detection at night. Electromagnetic effects other than infrared are receiving close study.

Typhon System

For the period from 1965 on, the Navy has launched development of a missile system for its ships which is all purpose in character from surface to air, anti-missile missile, surface-to-surface and surface-to-subsurface. It is the Typhon system.

Generally, the name Typhon has been applied to a missile with range capabilities up to 250 mi. Actually, the system will be able to launch a number of different missiles.

Heart of the system is a powerful radar wave generator located in the lower part of the ship. The generated waves are directed by a wave guide to the top of a tower where a Luneberg lens directs the waves in multiple directions. The tower installation resembles an oversize smokestack. Data and guidance systems would be tied into it.

Completion of Typhon development is threatened in two ways, high cost of shipboard installation, and worth of the system when compared with other ways of performing the same task. It is estimated that the smallest ship that will be able to take the system will displace 8,000 tons, the size of a pre-World War 2 cruiser.

One program scuttled in 1961 was the Missileer aircraft. This concept would have had a subsonic fighter aircraft loitering on station within line-of-sight contact with command aircraft or ships and carrying long range Eagle missiles. Instead of a supersonic aircraft making an interception of an enemy aircraft, the missile would do the job.

McNamara canceled development of the aircraft but allowed sufficient funds for further work to proceed on the missile. Navy is working on a missile which would utilize the first stage of the two stage Eagle for use with other aircraft.

Navy is continuing procurement on the Bullpup air-to-surface close-support missile, which will also be used by the Air Force, the Sidewinder air-to-air infrared-seeking missile; the Sparrow 3 radar guided air-to-air missile, rockets, bombs and napalm, Talos, Terrier and Tartar ship launched anti-aircraft missiles. Hawk surface-to-air battlefield anti-aircraft missile for Marine Corps use.

Space Activities

Navy participation in space activities is limited but varied. Its Spasur for a space surveillance system, is now operating as part of Space Track which in turn is part of the North American Air Defense Command (NORAD).

Pacific Missile Range is the responsibility of the Navy. Operational testing of Air Force ballistic missiles from Vandenberg AFB, Calif., is conducted on PMR ranges. Polar orbit launches make use of PMR tracking facilities. PMR tracking equipment also services the Mercury orbit flights of National Aeronautics and Space Administration.

Navy is assigned only one operational space system. It is the Transit navigation satellite. Transit is designed to aid ships determine their positions to accuracies of 0.1 mi. Operational systems in combat ships will have this degree of accuracy, while commercial vessels will be able to determine position to about one-quarter mile.

Operational Transits will be placed in polar orbits from the Navy's Pt. Arguello facility. The system is expected to be operational in 1964.

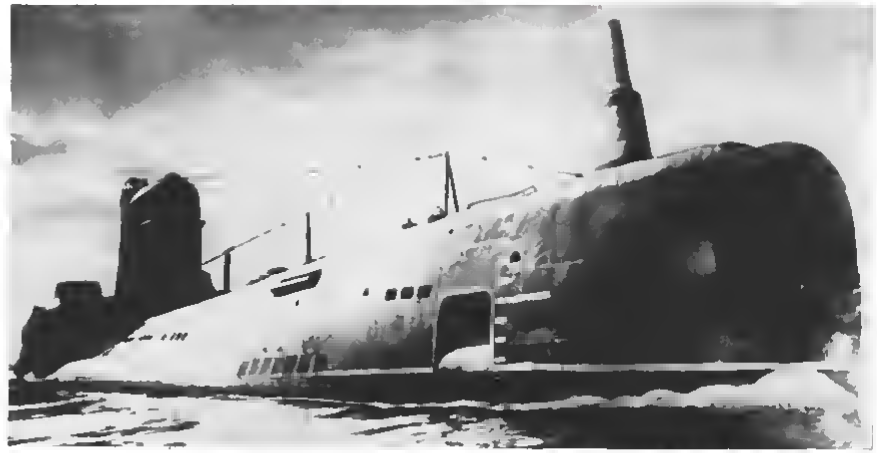
An attempt was made by the Navy, in January, to place five payloads in orbit in one launch, but the booster failed. Future scientific payloads will be launched individually by smaller boosters.

Navy Aircraft on Order

AIRCRAFT TYPE	POPULAR NAME	MANUFACTURER
A4D-5	Skyhawk	Douglas
A2F-1 and 1Q	Intruder	Grumman
A3J-1	Vigilante	North American
F4H-1 and 1P	Phantom 2	McDonnell
F8U-2NE	Crusader	Chance Vought
HRB-1	Seaknight	Boeing-Vertol
HU2K-1	Seasprite	Kaman
HSS-2	Sea King	Sikorsky
P3V-1	Trident	Lockheed
W2F-1	Hawkeye	Grumman
T3J-1	————	North American
S2F-3	Tracker	Grumman
GV-1	Hercules	Lockheed

Navy Missiles and Space Vehicles on Order

MISSILE or VEHICLE	MISSION	MANUFACTURER
Polaris	Submarine-to-Surface, Ballistic	Lockheed
Sparrow 3	Air-to-Air	Raytheon
Sidewinder	Air-to-Air (Infrared seeking)	Philco
Bullpup	Air-to-Surface	Martin
Terrier	Surface to Air	General Dynamics
Talos	Surface-to-Air	Bendix
Tartar	Surface-to-Air	General Dynamics-Applied Physics Laboratory
Hawk	Surface-to-Air	Raytheon
Transit	Navigation Satellite	Applied Physics Laboratory



RUSSIANS describe submarine in this photo as having missile launching capability. Missiles presumably are in housing at stern.

Army Undergoes Technical, Administrative

Army is in the midst of adjusting to a sweeping reorganization ordered in January which abolished some of the technical and administrative services, changed the character of others and drew all development activities and logistic support from the technical services into a new Materiel Development and Logistics Command (MDLC).

A measure of the blow to tradition can be gained by noting that four of the services date their existence from 1775. These are the Corps of Engineers, Chief of Finance, Adjutant General and Quartermaster Corps. The most recent addition was the Transportation Corps, created in 1942.

The technical and administrative services affected by the reorganization were:

- **Completely abolished.** Quartermaster Corps, Ordnance Corps and the Chemical Corps.
- **Functions changed.** Titles retained but statutory status abolished: Signal Corps, Adjutant General, Chief of Finance, Transportation Corps.
- **Retained as a separate entity** but statutory status abolished: Surgeon General.
- **Retained as a separate statutory service** because it performs many civil functions: Corps of Engineers.

Army carried its materiel organization shakeup a step further than the Air Force, which last year formed the Systems Command and Logistics Command by combining all in MDLC. The MDLC will thus be responsible for basic research in systems and other materiel, development, test, evaluation and logistics support after the materiel becomes operational.

Under the old organization each of the technical services performed its own research and development through widely scattered activities. The only coordination came from the Assistant Secretary of the Army (Research and Development) and the Deputy Chief of Staff (Development). Their control could not be absolute, however because of the statutory nature of the services, which were legal empires with a great measure of independence.

The reorganization will not produce any significant changes in the arsenals, laboratories, depots, test ranges and installations, except for centralized control.

Reorganization Objectives

Objectives of the reorganization are:

- **Elimination of duplication** of effort and excessive fragmenting of functions, responsibilities and resources.
- **Consolidation of responsibilities** for personnel management, training, combat developments, research and development and logistics functions in the smallest practical number of commands and agencies.
- **Improved effectiveness** by more clearly fixing responsibility for accomplishment of major tasks and by simplifying and strengthening the command and management structure.
- **Provision for** more flexible use of skills and broader technical opportunities for present military personnel.
- **Delegation of functions** which need not be performed at secretarial or staff level to subordinate commands.

An Army Combat Developments Command also was created in the reorganization. Its function will be the development of organizational and operational doctrine, materiel objectives and qualitative requirements, war gaming, field experimentation and cost effectiveness studies.

Training activities formerly performed by the technical services have been assigned to the Continental Army Command, whose scope will now include technical, administrative and combat training for the regular Army and the Army National Guard and Army Reserve.

A total of 120,000 men were added to Army strength last spring during the Berlin crisis through the call up of National Guard units and individual reservists. Repercussions to this call-up from political sources, who question the necessity of calling reserves for "show of strength" purposes, have caused the Defense Department to plan for greater regular Army strength rather than depend on reserves in the event of a cold war crisis. During this period, Army draft requirements were reduced from 25,000 per month to 9,000.

Nike Zeus Program

Nike Zeus anti-missile missile development program was accelerated in 1961 and continues as a priority program at present. Numerous firings took place at the White Sands, N. M., Missile Range from the Pacific Missile Range at Pt. Mugu and Kwajalein Island. An actual intercept of a Nike Hercules anti-aircraft missile was successful at White Sands.

Army's bid for preproduction funds for long lead time items of the system were denied by Secretary of Defense Robert S. McNamara for Fiscal 1963, however. This was also the case in the budget requests for Fiscal 1962.

Nike Zeus tests against Atlas ICBM re-entry targets are scheduled to begin at Kwajalein this summer. The Atlases will be fired from Vandenberg AFB, Calif., over the Pacific Missile Range. About 47 tests under controlled conditions are scheduled. If these tests are successful, there are indications that McNamara will then ask for funds to begin procurement of long lead time items, or procurement of the entire weapon system.

White Sands test was against the 3,000 mph. Hercules which was fired and then intercepted after it had passed its apogee. The miss distance was such that if the Zeus had been equipped with a nuclear warhead, the Hercules would have been destroyed. Atlas nose cones will pose a more difficult problem because of speeds five to six times as fast. Later testing against Atlas will also involve the ability to discriminate between the nose cone and decoys dispersed by the weapons.

Political Problem

Nike Zeus remains a political problem, principally between the Army and the Air Force. Air Force maintains that a system which would intercept ballistic missiles in their powered phase shortly after launch or in mid-course would be more effective. Such a system would have to be space-based. Army claims such a system is still only a study and that numerous concepts would have to be proved before development work could even begin. Nike Zeus, it says, makes use of known phenomena and proven concepts and can be a defensive system long before any other as a defense against ballistic missiles. At stake is the commitment of many billions of dollars for seven to 10 years and the prestige of operating such a defensive system.

In the tactical missile field, the Army is actively developing the Pershing solid propellant truck-mounted missile whose range has now been extended. Numerous firings from Cape Canaveral promise early production and deployment of the missile.

For a number of months beginning last fall it appeared that a bid would be placed on the upper range limit of Pershing. The Defense Department ordered the Air Force to develop a mobile mid-range ballistic missile, also solid propellant and truck mounted, which would have a range capability from 200 to 2,200 mi. The MMRBM would be aimed principally for NATO uses on the European mainland. It now appears that the missile is so involved in political wrangling on what characteristics it should have that it will be reduced to a study project. This action will permit development of the Pershing to the limit of its range capabilities, which the Army claims can be extended to as much as 1,000 mi.

Sergeant Missile

Overlapping the Pershing range envelope, is the Sergeant missile which has a maximum range of 75 mi. This missile was threatened with cancellation last fall by the Defense Department which claimed that the Army had too many tactical missiles in its inventory. Sergeant is now in production and its development is almost complete.

Shortest range nuclear warhead weapon in the Army inventory is the

Army Aircraft on Order

AIRCRAFT TYPE	POPULAR NAME	MANUFACTURER
AO-1 Observation	Mohawk	Grumman
AC-1 Assault Transport	Caribou	DeHavilland
HU-1 Utility Helicopter	Iroquois	Bell
HC-1B Transport Helicopter	Chinook	Boeing-Vertol
H-13 Utility Helicopter		Bell
H-23 Utility Helicopter		Hiller

Army Missiles and Space Vehicles on Order

MISSILE or VEHICLE	MISSION	MANUFACTURER
Sergeant	Surface-to-Surface	Sperry
Honest John	Surface-to-Surface	Emerson Electric-Douglas
Little John	Surface-to-Surface	Emerson Electric
Hawk	Surface-to-Air	Raytheon
Davy Crockett	Surface-to-Surface (Nuclear warhead)	ARGMA
Nike Hercules	Surface-to-Air	Douglas
SS-10, SS-11	Air-to-Surface	Nord
Pershing	Surface-to-Air	Martin

FAIRCHILD USD-5 DRONE

GRUMMAN AO-1 MOHAWK

Army Active Aircraft Inventory
(End of Fiscal Year)

1958	5,027
1959	5,199
1960	5 493
1961	5,564
1962 (Planned)	5 603
1963 (Planned)	5 894

Davy Crockett This jeep-mounted device has a warhead size larger than the rocket motor and can develop explosive power of as much as 20 kilotons, although conventional warheads and smaller nuclear warheads will ordinarily be used It has a range of 2 5 mi and can be operated by two men

Army is expending considerable effort into converting helicopters into missile-carrying vehicles with tactical combat roles Helicopter now being purchased in quantity for this purpose is the Bell HU 1, which can fire the SS 10 and SS-11 missiles These missiles are guided through wire reeled out while traveling toward a target The helicopter copilot guides the missile to the target

Hawk Uses

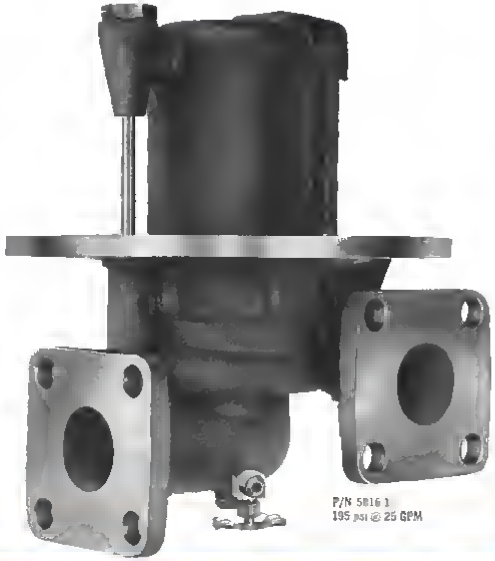
The Hawk is being produced for battlefield use against low flying planes It is also being purchased by the Navy for use by the Marines A new antiaircraft missile, the Redeye, has been developed but production has been delayed.

Army aviation has committed itself to the helicopter for all light aircraft work No new fixed-wing STOL light aircraft are being developed and there is no indication that off the shelf aircraft will be bought Fixed wing planes now in the inventory will be in use for the next six years but by that time the rotary wing aircraft will have taken over

To replace the fixed-wing aircraft the Army, with the Navy acting as procurement agent, has conducted a competition for a light observation helicopter (LOH) The characteristics as stated in the requests for proposals would call for a four-to-five place vehicle and a 250-shp turboshaft engine

Three contractors have been chosen to produce five aircraft each in this program They are Bell, Hiller and Hughes All are expected to have their prototypes flying this summer Powerplant is the Allison T63, which has been plagued with development troubles Although proposals have been asked for a substitute powerplant, it now appears that the T63 will be flying in all three aircraft this summer

After an evaluation period one of the designs will be chosen for production Since the number of aircraft over a period of years may reach 2,300 it is



P/N 5816-1
195 psi @ 25 GPM

FROM TASK—THREE NEW DIELECTRIC COOLANT PUMPS

Three unique design concepts enable Task's FC-75 pumps to realize unprecedented efficiencies for their small size. Exclusive vapor-cooled motor designs provides the simplicity of seal-less construction without incurring viscous and churning losses common to the submerged motor. Hydrodynamic performance is enhanced by utilizing an integral inducer-impeller. A novel internal boost system* assures cavitation-free performance even when reservoir pressure approaches that of the fluid vapor pressure. Combined with sound design and careful manufacture, these innovations result in exceptionally fine pumps.

For further details on Task's dielectric coolant pumps, phone PRospect 4-3100 or write: Task Corporation, 1009 E. Vermont Ave., Anaheim, California

P/N 5782-1
135 psi @ 7 GPM

P/N 3870-7
30 psi @ 2 GPM

*PAT. PEND.

Circle Number 82 on Reader-Service Card

AIRCRAFT MANUFACTURERS

PROTECT AGAINST IN-FLIGHT FAILURE with

LISLE CHIP DETECTORS

There's good reason why more and more manufacturers of aircraft engines, accessory drives, hydraulic systems and propellers are using Lisle Magnetic Chip Detectors.

Ferrous particles in a lubricant are a proven indicator of impending breakdown. The Chip Detector attracts these particles which bridge an electrically insulated gap, completing a circuit which activates a light on the instrument panel.

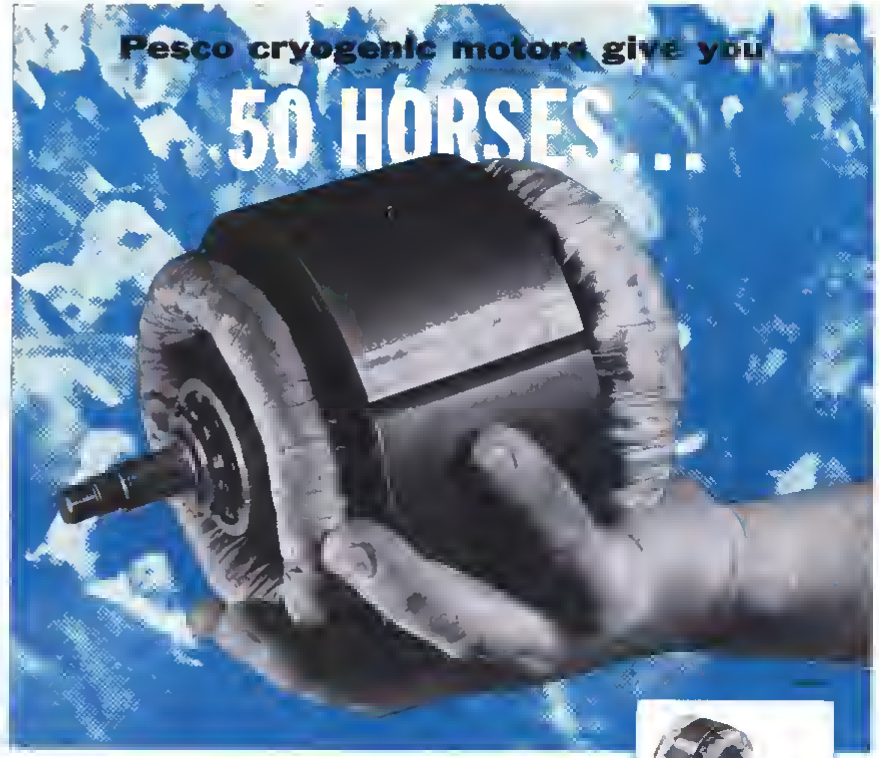
What about the equipment you make? Remember—early detection means constant protection against in-flight failure.

Write for Catalog and application data

Lisle

LISLE CORPORATION • CLARINDA, IOWA

Circle Number 79 on Reader-Service Card



in the palm of your hand!

Electric motor reliability, direct drive simplicity to operate in fluid temperatures to —459°F

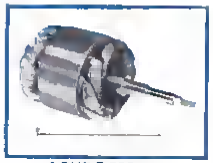
Pesco Cryogenic liquid cooled DC and AC induction motors are available for a wide variety of applications from 0.2 to 50 HP with speeds from 600 rpm, 60 cycle to 25,000 rpm, 400 cycle. Operating at temperatures between —459°F and —150°F, PESCO Cryogenic electric motors produce up to 5 HP per pound — three times more than hot gas turbines — five times more than conventional electric motors.

Each motor is designed to run fully submerged, eliminating the need for seals, insulation, gearbox, long shaft, lubrication system, and special handling for cryogenic gases and liquids. The result — efficient, lightweight, high speed motor-driven pumps or generators with reliable start-up and operation.

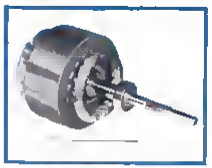
Pesco AC induction motors have been tested in excess of 300 hours at 12,000 rpm submerged in liquid hydrogen, maintaining full efficiency and performance.

Write Dept. 87 for complete information about Pesco Cryogenic Electric Motors.

.2 BHP 11,000 rpm



.4 BHP 7,500 rpm



10 BHP 23,000 rpm

PESCO PRODUCTS DIVISION
BORG-WARNER CORPORATION
24700 NORTH MILES ROAD • BEDFORD, OHIO
EXPORT SALES
Borg Warner International Corporation, 36 Wabash Ave., Chicago 3, Ill.

BORG WARNER

Circle Number 83 on Reader Service Card

SERGEANT WITH TRANSPORTER-LAUNCHER

possible that two contractors will be selected to produce the one model.

By Defense Department order, the Army is held to operating aircraft of 5,000 lb. or less unless specific exceptions have been granted. Exceptions have been granted for the de Havilland AC-1 Caribou twin-engine short-takeoff and landing troop-cargo transport which can operate from unimproved fields, the Grumman AO-1 Mohawk twin-turboprop battlefield reconnaissance aircraft which is produced for three separate missions, and the tandem-rotor Vertol HC-1 Chinook troop-cargo helicopter. Army would like another exception granted to allow it to perform its own close-support mission with fixed-wing aircraft, claiming that the Air Force has limited its tactical mission to nuclear delivery capability with high-performance aircraft which are not suited for extremely close troop-support missions.

VAX Studies

In order to accede to Army ideas for close support, the Defense Department last June ordered studies to begin on a VAX close-support aircraft for use by the Air Force Tactical Air Command. This was split off from McNamara's order for an all-in-one tactical fighter, the TFX, which was to perform the close support, air superiority, reconnaissance and interdiction roles.

The characteristics of the VAX have not yet been settled. Air Force and Marine pilots say that they do not want to fly a subsonic aircraft, claiming that there must be some chance of survival against high-performance aircraft. Since the TFX has not yet been ordered into development, it now appears that a decision on the VAX will wait for determination of TFX close-support performance capabilities.

Army aircraft inventory has been steadily growing. The Army now has permission to buy its own aviation equipment and off-the-shelf aircraft. It is building a cadre of trained personnel which in the future will be able to administer procurement of aircraft from design study through development to production. At present, the Defense Department requires that the procurement be done through the Air Force and Navy.

Future Needs

For the future, the Army wants to have each division equipped so that it can carry at least one company by air. Each cavalry squadron of a division will have an aerial reconnaissance troop. Aerial surveillance will match the fire power of each combat echelon.

Army wants a helicopter that can carry 13,000 lb. It hopes to purchase several Sikorsky S-64 flying cranes for evaluation of its short-haul heavy-lift needs.

In the field of vertical takeoff vehicles, the Army is funding several research efforts, but progress has been insufficient to justify development of a vehicle. Ground effect machines are being tested but no vehicle yet shows enough promise to order full development. STOL research, that is, in the order of 30 kt. stall speed and under, is not being pursued.

Army will continue to use the contract method of maintaining and overhauling its aircraft. At present only enough of this type of work in the continental U. S. is being done by Army personnel to allow training of new personnel and permit proper employment of personnel who are rotated from overseas.

Contract training of pilots and enlisted aviation personnel will continue.

Space Field Activities

Army activities in the space field are limited to the operation of a missile range and the development of two satellites.

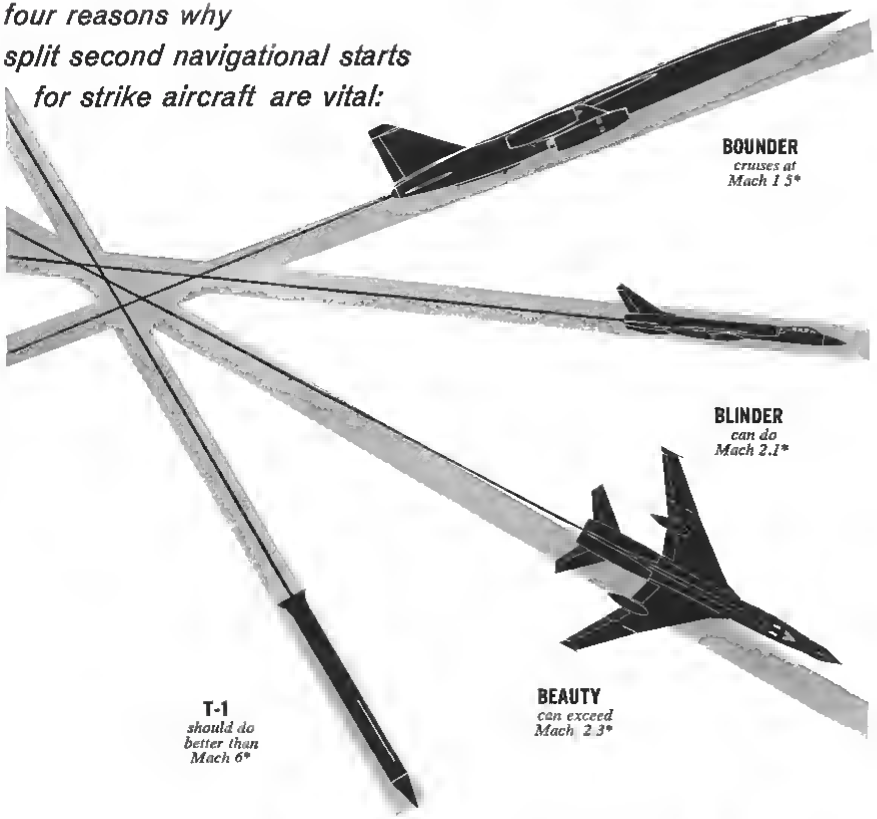
The White Sands Missile Range is used for high-altitude probes and has both a space tracking and communications capability.

Army has responsibility for developing the Advent military communications satellite. Advent is expected to be operational in 1964.

Since Army has the principal responsibility for geodesy and mapping for the Department of Defense, it has been given the task of developing the all-service Anna geodetic satellite. The satellite would perform more accurate measurements of the aberrations in the shape of the earth and the distances between datums on the continents from which land measurements of great accuracy already have been made. Ballistic missile guidance is such that the greatest chance of error now comes from lack of knowledge of exactly where a target is located in respect to the launching point.

BELL HU-1B WITH 48 2.75-IN. AIRCRAFT ROCKETS

four reasons why
split second navigational starts
for strike aircraft are vital:



. . . but inertial navigation systems for strike fighters use up precious *minutes* in warm-up time. LFE's Doppler navigation systems are always on ready alert, start in *seconds*

Inertial navigation systems' inaccuracies increase with time, but LFE's Doppler navigation system accuracy is constant — regardless of mission length

LFE's Doppler navigation technique is service proven aboard the F-105 tactical fighter-bomber. Its demonstrated accuracy and reliability is available *now* for all V/STOL, STOL, and other aircraft

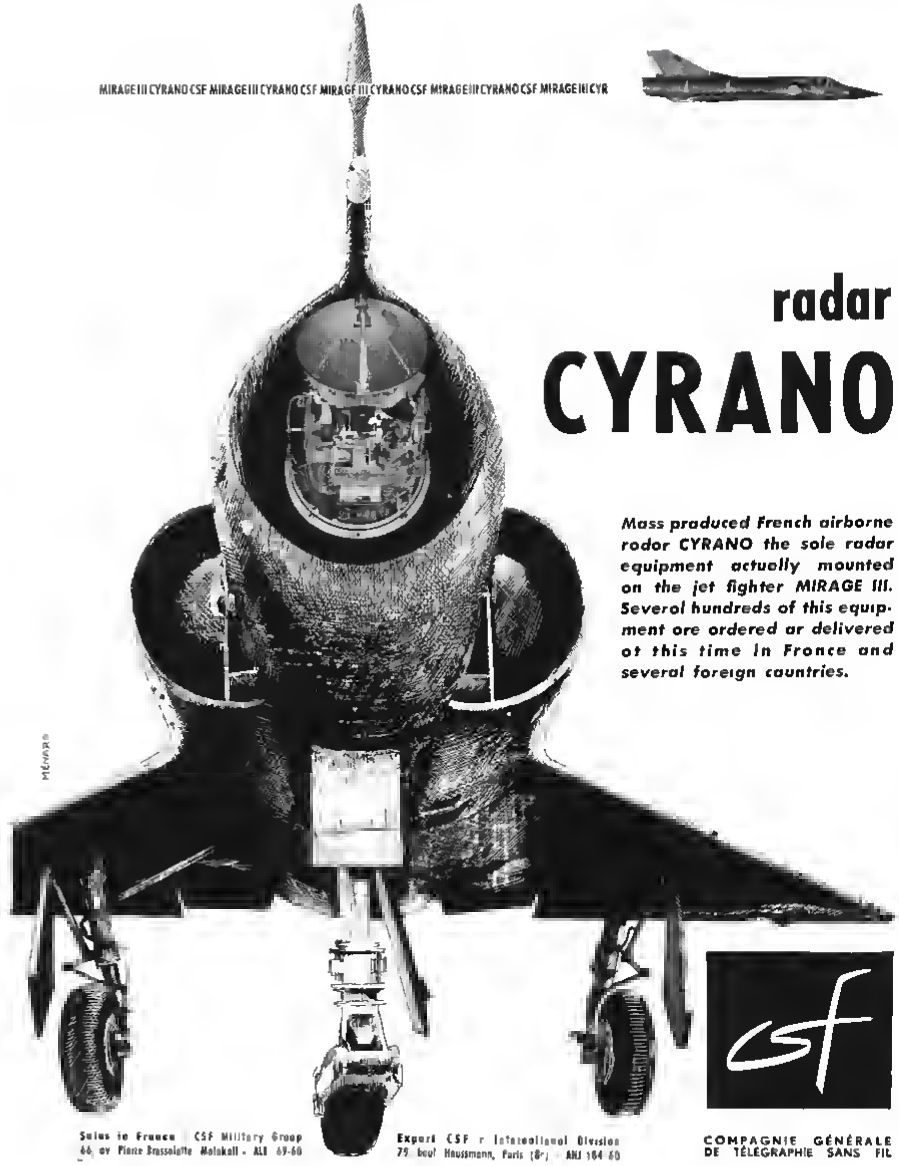
**From estimates in Air Force and Space Digest magazine*

LFE SYSTEMS

LFE ELECTRONICS

A DIVISION OF LABORATORY FOR ELECTRONICS INC
Boston 16 Massachusetts

Systems Equipment and Components for Airborne Navigation • Radar and Surveillance • Space Radars for Altitude Rendezvous and Velocity • Ground Support • Microwave Instrumentation • Air Traffic Control • Situational Displays



radar
CYRANO

Mass produced French airborne rodor CYRANO the sole radar equipment actually mounted on the jet fighter MIRAGE III. Severol hundreds of this equipment ore ordered or delivered ot this time in Fronce and several foreign countries.

csf

Sales to France : CSF Military Group
66, av Pierre Brossolette Malakoff - ALE 69-60

Export CSF : International Division
79, boul Haussmann, Paris (8e) - ANJ 164-60

COMPAGNIE GÉNÉRALE
DE TÉLÉGRAPHIE SANS FIL

BOEING C-135 begins airlift of U.S. troops to Germany for North Atlantic Treaty Organization exercise.

Joint Projects Test NATO Cohesiveness

By Cecil Brownlow

Paris—North Atlantic Treaty Organization members this year face a series of challenges and decisions that could seriously affect the structure of the organization as a whole, its future effectiveness and the primary direction of its efforts.

On the surface, there is the question of Berlin and whether NATO may have to face the ultimate test there. Internally, there are problems that, while not so immediate, must be solved if the organization is to remain a decisive factor in world politics and attain the cohesiveness it must have to do so.

In essence, the questions that must be answered are these:

- **Should NATO** become the world's fourth nuclear power with its own atomic stockpiles? The U.S. advanced a proposal along these lines well over a year ago, and it was embraced in principle by the West Germans. Other governments have been more reluctant for a number of reasons. Who will control the warheads and how, they ask, and who will have to pay and how much?
- **How can weapon system standardization** be achieved, at least within Europe, and how shall ensuing cost increases be absorbed, particularly when each of the major countries has a pet home-grown product of its own and is loath to accept someone else's hardware?
- **Should NATO expand** the scope of its activities into economic and political spheres as originally proposed by a former director general, Paul-Henri Spaak? The combined forces of the Soviet strategy of economic penetration into underdeveloped, uncommitted nations—and its threat of ultimate political control—plus the potential cohesive impact of the Common Market have sparked renewed demands that NATO widen its activities beyond the realm of the purely military and beyond the boundaries of Europe. There also is hope that, as the Common Market reaches maturity, the nationalistic pride over home-developed weapon systems may decline.

All of these propositions entail sacrifice of sovereignty and/or pride, and therefore represent no easy solutions.

VTOL Competition

Perhaps the most immediate test—and one that is now being fiercely fought—revolves around the NATO competition for a standard VTOL strike reconnaissance fighter for member nations. At least 12 proposals from the industries of six countries were submitted before the Jan. 10 deadline. At that time some factions were still debating the merits of the program under its present performance specifications and others notably France indicated that they would go it alone unless a design of theirs was chosen.

If the project disintegrates into a series of national programs rather than a common development and manufacturing effort spread among the countries involved, some observers believe the internal strength of NATO will suffer a severe blow. Such a move they believe, could effectively destroy the painful progress toward standardization made thus far and possibly cause deep nationalistic strictures that will be slow to disappear.

The need to prevent such splintering is generally recognized. The question once again is how. Each nation has its own approach, beliefs, peculiar defense needs and internal problems.

France, as an example, still resents the selection of the Fiat G-91 in an earlier competition for a standard close-support fighter. When it was chosen France withdrew its support from the program. In the present round, France let it be known early that its favored entry, the Sud-Dassault Mirage 3V, a VTOL outgrowth of the Mirage 3 interceptor, already is a nationally funded program, the winner of a national competition to fill a national need, and a program which it would be glad to share with others. If the others decline and another design is selected, the chances are strong that France will continue the program on its own.

Britain, with an airframe industry to support, has its own favored entries, which it also is more than willing to share. Acceptance of a foreign design could be politically unpopular as well in Britain. Purchases of such equipment in the past—i.e., British Overseas Airways Corp.'s decision to buy the Boeing 707 jet transport, choice of the Douglas Skybolt for the V bomber force—have been severely criticized.

Germany, with pride in its reinvigorated industry, thinks proper recognition is due for its efforts and for its military, financial and political support to the NATO cause.

U. S. Support

The U.S., a potential buyer and almost certainly a financial supporter, has seldom been inclined toward foreign equipment.

Among the common program's supporters within NATO, there is a feeling based upon hope and a knowledge of the possible consequences of failure that the nations involved will finally agree upon a common design—or possibly designs—to handle various types of missions. "We've been talking about how NATO is coming closer together," one official says. "This is a big test and it's one reason why I think it will go through."

Should the competition evolve into a requirement for more than one type of aircraft, say, one for close support and another for high-altitude interception along the pattern of defense requirements stated by the Germans and others, it could serve a practical need and, perhaps as importantly, ease the demands of individual countries for prime-contract recognition. Particularly helpful in this respect is the embryo parallel requirement for a medium-range V/STOL transport. This," a spokesman says, "would give us some room for maneuver. One country gets this another this and another that. We could have some horse-trading and the end result would benefit everyone."

British Powerplants

England stands a strong chance of representation in the engine field in either the transport or fighter categories—or both—since Rolls-Royce or Bristol Siddeley powerplants are represented in a majority of proposals. France, in turn, might be willing to accept a German-designed transport in return for selection of a French fighter in the NATO competition.

However the programs evolve, such political considerations are destined to play an important part. Technological superiority will be a factor in the

REPUBLIC F-105Ds of the 36th Tactical Fighter Wing based at Bitburg, Germany, are a U.S. contribution to NATO forces.

FIRST HARDWARE produced in a joint NATO project is the Breguet 1150 Atlantic anti-submarine aircraft.

selection but, most observers agree, probably not the overriding one. A NATO-assigned officer close to the program observes:

"It's going to be delayed. There's going to be foot dragging and, in the final analysis, the decision isn't going to be made on the working level. There's going to have to be a lot of give and take."

Another hurdle that must be overcome is funding since there is no NATO money as such for either project. Dealing only with the strike fighter—the transport is farther away since no definite requirements have yet been stated—the NATO officer agrees that no one country can afford it on its own without outside help at the start, although considerable funds already have been expended by individual firms on their respective design proposals. "If the countries don't support it," he said, "it's going to fold."

Such support almost invariably will require U.S. fund sharing, at least in the areas of development and prototype production, and a strong American stand coupled with a promise of aid could be a factor towards mitigating national demands. The U.S., however, is not without its own pressures.

Mutual Funds

Mutual aid funds have gone into the development of a family of British engines, the Bristol Siddeley BS.53 and the more powerful BS.100 variable-thrust powerplants. In return, the American government has royalty free production rights to them in the U.S. American airframe and engine designs, notably the General Electric T64 turboprop on transport entries, are deeply involved, and to some U.S. companies the difference between win and lose is of more than passing importance.

American firms are looking to the government to watch over their interests before providing financial aid. One industry representative says somewhat bitterly: "There's going to have to be U.S. money to get this project moving but do you think the government is going to insist that we get some work or royalty fees out of it the way the Europeans are doing? My bet is that it won't."

Another representative adds:

"The government keeps telling us that we should get in and sell our products in the Common Market area so we don't get left out. Then, when we want to propose something over here we're frozen out. We've been trying for over a year to get [State Department-USAF security] clearance to talk about one of our projects. It came through last week. Now, it's too late."

And, within NATO itself, there are those who doubt the wisdom of having allowed the V/STOL programs to become sponsored projects, particularly in view of the possible results of failure. One official, who sees little hope of any early agreement on the transport side, says of the fighter program:

"At least three production models are going to be built, and it's going to break up into a national thing. Can you see the French building an Italian design?"

Another more optimistic source contends that both the strike fighter and transport competitions will be resolved with no real problems that cannot be overcome. "People overlook the fact that NATO has made some common decisions in the past and instead play up their past differences," he said. "Each country has its needs and pride.

"I think the best design in both the transport and strike fighter will be chosen."

Nuclear Control

The questions of nuclear arms control are as involved.

France is building its own national nuclear force in hopes of obtaining full political parity with the other two members of the Western Big Three. It is completing plans for a strategic air command equipped by 1965 with Dassault Mirage 4 nuclear-carrying bombers.

A total of 50 of the aircraft is currently on order by the French government. French also are aggressively developing a solid-fuel intermediate range ballistic missile with a range of 1,500-2,500 mi., and the nuclear warhead that goes with it. Planned operational date reportedly is between 1968-70.

U.S. and French laws conflict on this subject. U.S. legislation prohibits any U.S.-warhead from escaping American control. French law, on the other hand, forbids the presence of U.S. nuclear warheads in the territory of France unless they come under French control. The combination of these two resulted in the withdrawal of nuclear-equipped U.S. tactical fighter units from France in 1959 when the French law went into force. France undoubtedly would welcome any move that would relax other U.S. restrictions that prohibit American firms from giving aid to their French counterparts in the development of an IRBM or provide it with nuclear warheads in the interim before its own force comes into being.

It is doubtful, however, whether France is willing to divert substantial funds from its own programs to help NATO as such to become a nuclear power. The same is true for most of the other nations involved with the exception of West Germany. The Germans have the necessary financing to carry their end of the bargain. They also recognize the fact that they can expect little or no warning in the event

NORTH AMERICAN X-15


MARTIN TM-76B MACE


LOCKHEED F-104


BEECHCRAFT B95A TRAVEL AIR

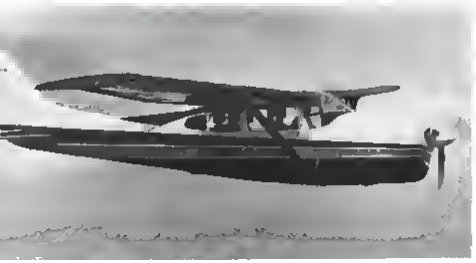
CONTROL

Why does the aerospace industry use more Cutler-Hammer switches and power relays than any other brand?

DOUGLAS A4D-2N

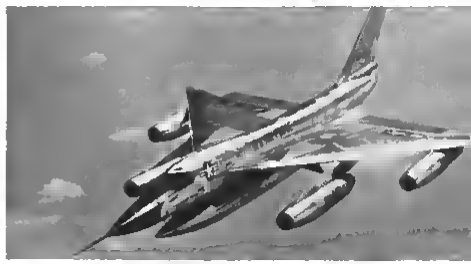
NORTHROP T-38


McDONNELL F4H-1


CESSNA 210

SIKORSKY HSS-2


KAMAN H-43B HUSKIE


GENERAL DYNAMICS B-58


REPUBLIC F-105-D


RYAN Q-2C FIREBEE


BELL 204B


BOEING 720

Reliability . . . breadth of line . . . experience have made

Cutler-Hammer first choice for switches and power relays

You'll find Cutler-Hammer switches and relays in all types of aircraft from private planes to missiles.

All the manufacturers represented in these photos—and many more—have made Cutler-Hammer a preferred source. Since 1920, when we designed and manufactured the first line of switches ever created specifically for aircraft use, Cutler-Hammer has been the standard of quality for the industry.

Our engineers are always ready to help you select the best possible switches, Class O and hermetically sealed power relays and circuit breakers from our extensive line. Or, they'll work with you in design and manufacture to help you solve your particular problem. Better yet, get in touch with your Cutler-Hammer sales office *before* a special problem comes up. For more information, write for Pub. EE 140-E-286—88 pages of detailed information.

WHAT'S NEW? ASK...

CUTLER-HAMMER

CONTROL

Cutler-Hammer Inc., Milwaukee Wisconsin • Division Airborne Instruments Laboratory • Subsidiary Cutler-Hammer International, C. A. • Associates Cutler-Hammer Canada Ltd.; Cutler-Hammer Mexicana, S. A.

Circle Number 93 on Reader Service Card

of enemy attack and that the present, logistically-cumbersome system of retaining the warheads in stockpile under U S control until they are needed simply may not work at a time when it must.

Other nations are just as happy to avoid the onus of nuclear responsibility, leaving it to the U S to provide the weapons when and if the time comes. Presence of nuclear warheads in Norway or Denmark, for example, undoubtedly would touch off violent reactions from within the Soviet Union and domestically.

An overriding factor is how NATO warheads would be controlled—who could give the command to fire, particularly if the warheads were located aboard a Polaris missile submarine at sea in international waters rather than on national territory.

Under present law, they certainly could not be fired without a U S presidential order. U S supplied nuclear warheads for Douglas Thor IRBMs in Great Britain theoretically are under joint control, with a U S officer carrying one key, his British counterpart another, both of which ostensibly must be used to actuate the firing system. The use of 15—or even 5—keys would be awkward to say the least, not to mention the 15 orders to fire that would have to come from the respective national capitals.

Herter Suggestion

Former Secretary of State Christian Herter originally made the fourth-power suggestion, with the backing of Supreme Allied Commander Gen. Lauris Norstad, during the waning days of the Eisenhower Administration. Basically, the Herter proposal suggested that the U S might be ready to commit five Polaris submarines to NATO control if the other member nations responded with the purchase of at least 100 of the missiles for use on land under a NATO wide command.

Support for a similar program was voiced by President Kennedy last May. However, visible evidence of support from other quarters has been lacking and probably will continue to be lacking without major concessions on both sides.

So far as a broadening of NATO activities to encompass the realms of politics and economics is concerned, Spaak's concept held that, as the cold war increases in intensity, the organization should move into these spheres to carry out its mandate of effectively deterring Communist aggression.

Proponents of the plan still support this dictum, with the Common Market giving it new impetus. Concerted moves on both the political and economic fronts also may be made easier as the former colonial nations among the

membership relinquish their former territories. Colonial interests have been a divisive force in attempts to reach accord as to relations with underdeveloped areas.

It will still require subjugation of traditional national aims and prerogatives if this goal is to be reached, and concrete results may be slow in coming.

In the face of the more immediate crisis—Berlin—the build up of West German forces toward their assigned goals and a bolstering of U.S. units in Europe helped offset a planned reduction in the British Army of the Rhine as an economy measure and the continued presence of most of France's combat strength in Algeria.

The U.S. build up in the face of the Berlin crisis has created the strongest American air command ever maintained outside the U.S. in peacetime, according to United States Air Forces in Europe headquarters. Because of the facilities cramp in other areas, it also resulted in the return of USAF tactical fighter units to six French airfields although presumably without their nuclear stores.

Mainstay of the new force is 11 National Guard squadrons distributed among fields in France, Germany and Spain. Three are equipped with Lockheed F-104As, three with North American F-86Ls and five with Republic F-84Fs.

All-Weather Capability

In another strengthening move, USAFE during the year obtained its first all-weather tactical fighter capability with the introduction of the Republic F-105 to two German-based units—the 36th and the 49th Tactical Fighter Wings. A third F-105 wing is scheduled.

Early this year, in a further effort to show the Soviets the U.S. is willing and has the capability to fight over Berlin if necessary, the Air Force airlifted almost 6,000 men of three infantry battle groups from McChord AFB, Wash., to Frankfurt in a week-long exercise involving a total of 100 aircraft, 10 of them Boeing C-135 jet transports. The C-135s flew a 5,100-mi. nonstop polar route from McChord in a scheduled time of 10 hr., 15 min. Once in Europe, the troops were deployed by helicopter to the field for a series of maneuvers with other units under NATO control.

Whether or not the Soviets were impressed, the Western allies obviously were and the added U.S. strength did much to assuage doubt as to whether the U.S. would be willing to risk an all-out war, with its resultant threat of nuclear blows against the North American continent, in order to contest European real estate against Communist aggression.

NASA SATURN booster is successfully launched at Cape Canaveral for its initial flight

Space Technology

U. S. Accepts Challenge in Race for Space

By Edward H. Kolcum

White House decision to press for a manned lunar landing in 1967 has set the pace for the entire U. S. space program, but success will depend on the nation's ability—government, industry and the public—to sustain a costly and technologically demanding effort.

Manned space flight dominated both U. S. and Soviet space programs in 1961, and the domination will become even more pronounced in this country as advanced Mercury, Gemini and Apollo vehicles are translated from concept into hardware.

Most obvious reflection is in the National Aeronautics and Space Administration budget. Of nearly $4 billion in new money in Fiscal 1963, the agency is requesting 68% for manned space flight. Current forecasts are that the budget will reach $5-$6 billion the following year, 80% of which will go to support manned space flight programs.

Although NASA was established and a space program started under the Eisenhower Administration, top level backing for a dynamic space program did not come until President Kennedy took office. The political overtones in the program have become sharp and clear, but with them has come a dramatic and daring national objective—landing men on the moon—which everyone can appreciate.

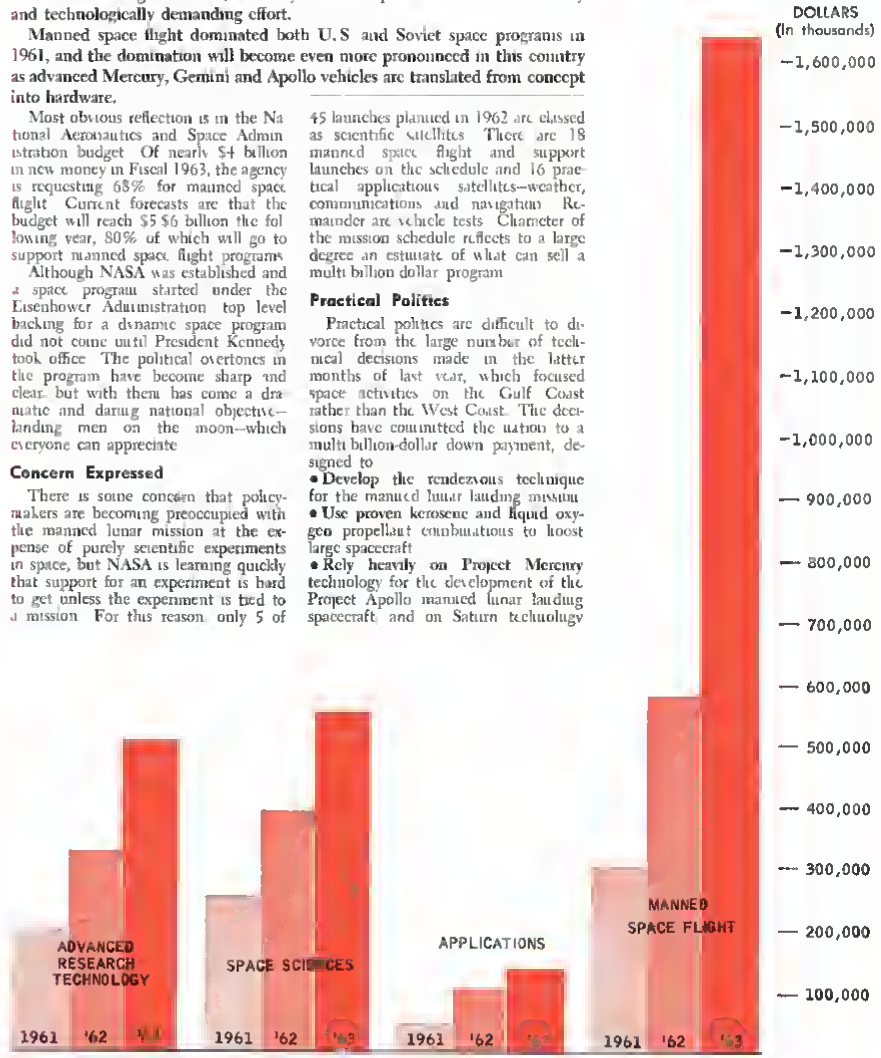
Concern Expressed

There is some concern that policymakers are becoming preoccupied with the manned lunar mission at the expense of purely scientific experiments in space, but NASA is learning quickly that support for an experiment is hard to get unless the experiment is tied to a mission. For this reason, only 5 of 45 launches planned in 1962 are classed as scientific satellites. There are 18 manned space flight and support launches on the schedule and 16 practical applications satellites—weather, communications and navigation. Remainder are vehicle tests. Character of the mission schedule reflects to a large degree an estimate of what can sell a multi-billion dollar program.

Practical Politics

Practical politics are difficult to divorce from the large number of technical decisions made in the latter months of last year, which focused space activities on the Gulf Coast rather than the West Coast. The decisions have committed the nation to a multi-billion-dollar down payment, designed to:

- **Develop the rendezvous technique** for the manned lunar landing mission.
- **Use proven kerosene and liquid oxygen** propellant combinations to boost large spacecraft.
- **Rely heavily on Project Mercury** technology for the development of the Project Apollo manned lunar landing spacecraft, and on Saturn technology.



THREE-YEAR NASA R&D budget comparison emphasizes manned space flight growth

for development of the C-5 vehicle which will launch Apollo.

Most far-reaching decision, after manned lunar flight was made a national goal, was the one to develop rendezvous as the primary means for conducting the mission. Alternates to the rendezvous approach—solid and liquid propellant, direct ascent Nova vehicles—were immediately relegated to lower priorities. The liquid propellant Nova is still in the development schedule but it is unlikely that solid propellant motors larger than 156-in. diameter will be built soon.

Decision to use the rendezvous technique was made because this method will permit the manned lunar landing to be made at least six months earlier than direct ascent. However, NASA is asking for sizable sums for development of the liquid propellant Nova in Fiscal 1963, as insurance for the untried rendezvous concept and to provide a vehicle for flight beyond the moon.

Rendezvous will be conducted by launching a 200,000-lb. thrust J-2 engine, fully fueled, as the payload of a Saturn C-5. The two-stage C-5 will be powered by a five-engine cluster of F-1 engines as booster, and five J-2 hydrogen-oxygen engines in the second stage. A second two-stage C-5 then will launch the Apollo spacecraft, which will function as the chaser for the orbiting J-2 target.

The Apollo spacecraft is built around a 154-in. diameter re-entry vehicle and command module, essentially an enlarged version of the Mercury capsule. The afterbody is angled inward more sharply to decrease heat loads, and aerodynamic lift will be obtained by an offset center of gravity, permitting some maneuverability during re-entry.

Like Mercury, Apollo will be launched with an abort rocket tower that will be jettisoned after booster burnout. All members of the three-man crew will be qualified to perform the re-entry maneuver.

Preceding Apollo will be four 14-orbit missions with modified Mercury capsules and 12 Gemini missions designed to perfect the rendezvous technique, train Apollo crewmen, and provide up to 14 days orbital flight.

The two-man Gemini spacecraft will be 14% larger in all dimensions than the Mercury capsule, and one of its major tasks will be to evaluate components for the Apollo vehicle. Systems can be placed outside the Gemini pressure vessel without redesigning the overall configuration. Gemini will be launched by a Titan 2 and will rendezvous with an Agena B stage.

NASA wants the 18-orbit Mercury capsule to have an orbital weight of about 2,700 lb.—the same weight as the three-orbit capsule—so that further demands will not be placed on the Atlas D launch vehicle. To do this some of the systems that duplicate others will be eliminated, and some primary systems such as the periscope, may be removed.

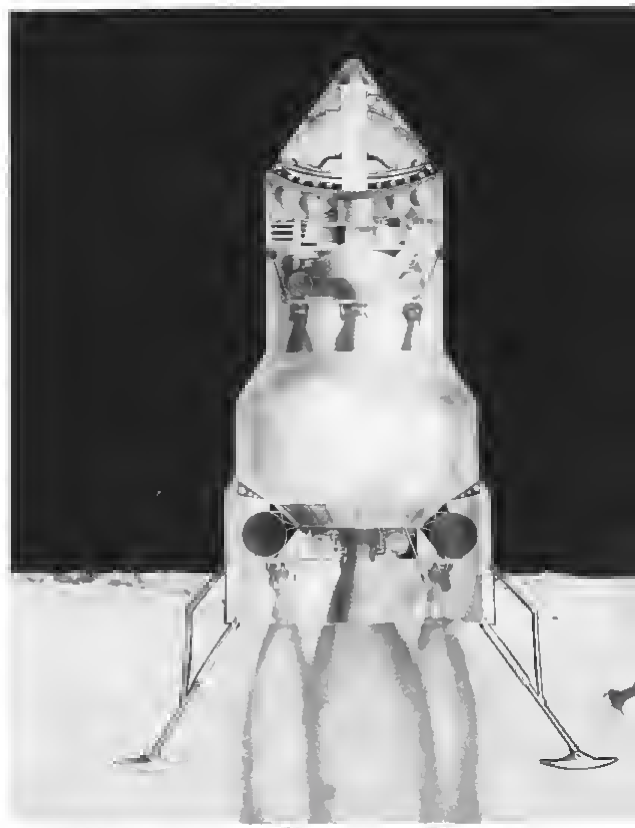
Booster development to accomplish these tasks remains the pacing item as it was a year ago. However, large launch vehicles were on a stretched schedule last year. Now the final stretchout has been eliminated.

The ambitious and revitalized space program has as its principal architect the National Aeronautics and Space Council, headed by Vice President Lyndon Johnson. The council mapped the lunar program and sold it to President Kennedy not only for its prestige value, but also for its domestic economic effect. With approval of the program, NASA quickly awarded contracts for flight hardware and development facilities and began a massive drive to recruit as many as 5,000 more scientists, engineers and technical support personnel, to bring its total staff to 26,273. The agency reorganized to focus its effort on manned space flight.

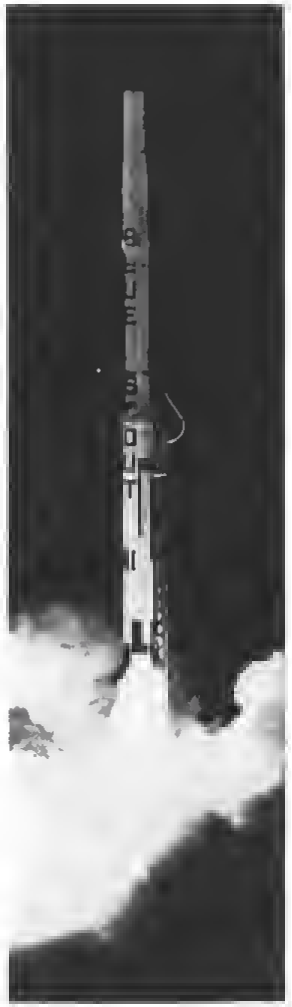
Most significant actions taken since mid-summer include:

• **Contract to Chrysler** to fabricate the Saturn S-1 booster stage, an eight-engine cluster of Rocketdyne H-1 engines. The vehicle, Saturn C-1, will have an S-4 second stage powered by a cluster of six Pratt & Whitney RL-10 A-3 hydrogen-oxygen engines.

• **Contract to Boeing** to produce the Saturn S-1C booster stage, a cluster of five Rocketdyne F-1 engines. A five-



APOLLO TYPE VEHICLE, depicted in artist's concept from National Aeronautics and Space Administration's Lewis Research Center, is shown in final stage of landing on moon's surface. Landing gear are extended to stabilize vehicle after touchdown.



Blue Scout 2 Launch

Blue Scout 2, U. S. Air Force four-stage, solid propellant rocket, developed by Ford Motor Co.'s Aeronutronic Division at Newport Beach, Calif., is shown during night launch from Cape Canaveral. Blue Scout 1-2 and 1-2-3 configurations will be used as boosters in a test series scheduled to begin this summer at Canaveral of USAF's Project ASSET experimental re-entry vehicles (AW Feb. 5, p. 50).

engine cluster of Rocketdyne J-2 engines will power the second stage.

• **Contract to North American Aviation,** Space and Information Systems division, to develop and build Apollo command and service modules.

• **Contracts to McDonnell Aircraft Co.** to modify the Mercury capsule to conduct 18-orbit missions, and to enlarge the capsule for Gemini flights.

• **Selection of the Atlantic Missile Range** as the site from which large boosters will be launched; a surplus government assembly building in Michoud, La., near New Orleans, to manufacture and assemble S-1, S-1C and Rift (reactor in-flight test) stages; a site on the Pearl River in Mississippi to static test stages, and Houston as the site of a new Manned Spacecraft Center.

NASA Expansion

Few considered it possible that NASA could make the decisions so quickly for the expanded program, but with the impetus of President Kennedy's full support the major decisions were made and the major contracts placed.

The great personnel expansion of the agency—from 9,276 at the end of Fiscal 1959 to the proposed 26,273 at the end of Fiscal 1963—could easily prove to be one of its biggest problems. NASA is certain to be charged with over-management of its contracts since it is tending to enlarge resident staffs.

The NASA representative staff at McDonnell for the Mercury capsule numbered six. In contrast, the agency now has plans to staff one plant holding a vehicle contract with 50.

Against this background of intense activity, NASA plans a long-range launch vehicle family consisting of 10 vehicles, double the number considered necessary a year ago. These will be Scout, Delta, Thor Agena B, Atlas Agena B, Centaur, Saturn C-1, Saturn C-5, Nova. Atlas and Titan 2 Atlas D will be used for the Mercury program, and Titan 2 for Gemini. Before acceleration of the space program, it was NASA's plan to use only Saturn C-1, Centaur, Scout, Thor and Atlas boosted Agena Bs and Nova.

Firm Nova Design

Configuration of the Nova vehicle was not frozen until early this year. Booster will be powered by an eight-engine cluster of F-1 engines, and the second stage will consist of four M-1 hydrogen-oxygen engines each producing 1.2 million lb. thrust. Third stage will be a single J-2. Aerojet-General was awarded the engine contract for the Nova second stage, designated N-2, in late January.

Concrete results of the new administration impetus probably will not be

...ment for some years. However, the present NASA flight schedule has two 18-orbit Mercury missions scheduled late this year, and the first Gemini flights in late 1963.

Flight schedule for 1962 consists of:

- **Project Mercury**: at least three more flights in the manned three-orbit profile.
- **Advanced Mercury**: possibly one development flight.
- **Ranger**: three launches in attempts for an impact on the moon.
- **Mariner**: one Venus fly-by mission with a backup. Most favorable time for launch is late July to early August.
- **Re-entry**: three launches with the Scout vehicle to test structures, materials and configurations, and to provide data on re-entry physics.
- **Saturn vehicle tests**: two scheduled.
- **Centaur vehicle tests**: three scheduled.
- **Weather satellites**: four Tiros and a Tiros backup, and one Nimbus.
- **Communications satellites**: inflation test of the Echo 2 sphere, launch of Echo 2 passive communications satellite into orbit, launch of two American Telephone and Telegraph Co. Telstar satellites each with a backup, launch of two Relay satellites and launch of one Syncom A satellite.
- **Orbiting solar observatory**: a 440-lb payload designated S-16 is designed to study electromagnetic radiation from the sun.
- **Atmospheric structures satellite**: 375-lb package designated S-6 and designed to study composition, density, pressure and temperature of upper atmosphere.
- **Electron density probe**: 94-lb package called P-21a, will study ionospheric electron concentration and radio wave propagation.
- **Energetic particles satellite**: 83-lb S-3 payload to study the Van Allen radiation belt.
- **Micrometeoroid satellite**: 135-lb payload, S-55, to accumulate data on puncture hazards. This experiment will provide information on the design of manned and unmanned satellites.
- **Fixed-frequency topside sounder satellite**: 110-lb payload to study the upper ionosphere.
- **Canadian swept-frequency topside sounder**: 310-lb payload to study effects of the upper ionosphere on radio frequencies.
- **United Kingdom satellite**: 150-lb package designated UK-1 and S-51, designed to study the upper ionosphere.
- **SERT (Space Engine Research Test) vehicle**: a 150-lb probe designed to test ion and arc jet engines in a weightless environment.

Atlas D will launch the seven Mercury flights and Atlas Agena B the Ranger and Mariner vehicles.

Delta will launch the Tiros, Relay, Telstar, solar observatory, atmospheric structures, energetic particles and UK-1.

CARE AND FEEDING OF MISFIT BITS

(Or: Down to bedrock with EDP)

"Data," quoth one of our intrepid R&D Engineers in a moment of bemused relaxation, "are too often treated like a woman's foot!"

"The object," he elaborated, "seems to be to squeeze it into the smallest shoe available. It's axiomatic, of course, that *feet don't fit shoes. Vice versa. And data . . .*"—well, you know the rest.

Which is another way of saying that trying to solve a specialized data processing problem with a "standard" system will usually get you bunions . . . and a lot of wasted time and money. We frankly prefer to start with the data itself . . . and an unfettered mind. We've been doing it for something over 20 years, and you would find the results most interesting.*

Take, for instance, the Radar Data Processor we developed and produced for the 433-L Weather Observing and Forecasting Program. One big objective of this program is to generate composite radar displays of large storm systems. The idea is to get cloud intensity and height data from a hundred or so weather radar sets across the nation, and combine all this information at a single processing center.

Foregoing a treatise on the problems, let it suffice to say that a size 9 brown oxford data processor out of a box was "no fit" for the job. The unit as we produced it accepts the quantized grey levels of radar echoes from clouds . . . eliminates interference effects from practical consideration . . . and encodes the data in 7 intensity and 6 height levels. For each 5 by 5 nautical square mile area, maximum cloud intensity and the height of the highest cloud are stored in a magnetic core memory.

The radar unfortunately supplies its information in a spherical coordinate system, so we had to convert it for storage in rectangular coordinates, for ease of display. Conversion is accomplished with some interesting (see previous footnote) analog computation techniques. On command, stored data are transmitted either to a local display printer, or over phone lines to the central control station, or both.

There are also facilities for inserting code into outgoing messages, alarms to signal certain weather conditions, and internal test equipment for checking system performance. And there's a Telecoder with some unique capabilities that can be adapted for use wherever information on printed or punched tape has to be converted for serial transmission or readout. (If this is up your alley, write for Data Sheet 6-106.)

We'll gladly tell you more about what we've done, but we'd much rather talk about your current problem in converting data into "hard copy," telephone line signals or visual displays . . . or in developing specialized data handling systems or computer control centers. When can we get together? Data Processing and Display Systems Dept., Budd Electronics, 43-22 Queens St., Long Island City 1, New York.

*Term commonly used by R&D men in referring to their own accomplishments. Meaning: "Remarkably ingenious; nothing else quite like it."

payloads. Nimbus and the swept frequency topside sounder will be launched by Thor Agena B, and Scout will carry the micrometeoroid hazard satellite, electron density probe, fixed frequency topside sounder and SERT packages.

Even though the scientific satellite program is small in comparison to manned and applications satellite missions, NASA plans to continue a broadly-based effort designed to answer these basic unknowns:

- **Structures of stars and galaxies,** including the evolution of the stars elements in space and nucleosynthesis.
- **Origin and evolution of the solar system,** formation of the sun and structures of the planets.
- **Solar control** over the earth's atmosphere, causes of weather in the lower atmosphere, and structure of the upper atmosphere.

In his annual space report to Congress, President Kennedy listed these major scientific advances from launches during 1961:

- **Steady-state theory** of the origin of the universe was disproven by Explorer 11 as it pertains to continuous creation of matter and antimatter. The satellite failed to detect a continuous production of gamma rays, which would be present if the theory were valid.
- **Discovery of a helium layer** surrounding the earth from 600-1,500 mi., by Explorer 8.
- **Magnetic fields** between planets are more intense than had been believed based on Explorer 10 measurements.
- **Van Allen belts** actually consist of a single system of charged particles which vary in characteristics rather than two distinct belts. The zone reaches to the outer limit of the earth's magnetosphere, 40,000 mi. above the earth's surface. This was discovered by Explorer 12.

NASA's sounding rocket program continued its planned growth to an average of 100 firings annually with the launching of 70 sounding rockets last year. This program involves firings from Wallops Island, Va., and joint programs with Canada from Fort Churchill, and Australia from the Woomera Range.

Launch of Canadian and British satellites under joint programs this year begins what NASA hopes will be an expanding effort in international programs. The space agency and the government are encouraging launch of foreign experiments by U. S. vehicles and it is likely that the Scout all-solid propellant four-stage vehicle may be made available for direct purchase by foreign governments. Italy and Japan are expressing active interest in joint satellite programs, and these countries, Australia and Canada already are launching probes in joint programs with U. S.

PHOTO SEQUENCE of Lt Col John Glenn's Mercury Atlas 6 flight shows astronaut leaving Atlantic Missile Range Hangar S (left) carrying portable pressure suit cooling unit and accompanied by personal physician, Lt. Col William K. Douglas. Glenn entering his Friendship Seven capsule atop Atlas 109D (center), liftoff from Pad 14 at 9:47 a.m., Feb. 20, after 10 flight postponements (top right), and Glenn describing flight (bottom right) to Lt. Cdr. Scott Carpenter, at right, and MA-7 pilot designate, Maj. Donald Slayton.

Glenn Flight Improves U.S. Position in Moon Race

Successful orbit and recovery of the Project Mercury Friendship Seven manned capsule has opened a new chapter in manned flight and given the U.S. its greatest hope to date of landing men on the moon before the Soviet Union.

The flight of Marine Lt. Col. John H. Glenn, Jr., was the critical demonstration of the design concepts and procedures the U.S. will use for the five advanced manned space vehicles now in various stages of development. The first U.S. manned orbital flight proved the value of the human pilot, and Col. Glenn's flawless performance under stress will greatly influence the design of future manned spacecraft and selection and training procedures for the pilots who will fly them.

Col. Glenn was launched in his Mercury capsule as the payload of an Atlas D vehicle at 9:47 a.m. (EST), Feb. 20 from the Atlantic Missile Range. He landed off Grand Turk Island in the Atlantic Ocean 4 hr., 56 min. later, and during his three orbits he spent about three hours manually controlling the attitude of his spacecraft after the automatic control system failed in yaw.

Design Significance

Significance of the manual override may be demonstrated in the detailed design of the next U.S. manned spacecraft, a Mercury capsule with the capability to complete 18 orbits in 27 hr. of space flight. It is certain to affect design of the Gemini two-man spacecraft, and the three-man Apollo spacecraft—for earth orbit, circumlunar and lunar landing flights.

The Mercury capsule is essentially an automatic system, with the pilot on board as a scientific observer and monitor. He could go along for the ride, because the capsule has been proven flightworthy. If Col. Glenn had assumed the role of an observer, Mercury-Atlas 6 probably would have been taken out of orbit after two circles and the gathering of unprecedented visual and biomedical data would have had to await another flight.

As a result of Glenn's ability to control his capsule, manned space flight at least for short durations was found to be more akin to manned aircraft flight than had been thought possible. The real tests will come with extended flights of 1, 7 and 14 days planned during the next three years as a prelude to lunar landing. Soviet Maj. Gherman Titov has been said to have suffered inner ear effects after six hours of weightless flight (see p. 114), but after Col. Glenn's flight there is a growing belief that the adverse effects are individual and not general.

Glenn's ability to react correctly to the unexpected verifies an early decision to rely on engineering test pilots as astronauts. It means also that the number of backup systems can be reduced, and the concept of complete automation can be eliminated. This concept was a necessary part of Project Mercury, however, because there was no reliable precedent on which to base an assessment of man's performance in the space environment.

Col. Glenn's flight in MA-6 was made after ten delays caused by technical problems and the weather. The Friendship Seven capsule was injected into orbit after 300 sec. of powered flight.

Latest orbital elements show the MA-6 apogee was 162 mi., perigee 100 mi., period, 88 min., 29 sec., and inclination to the equator 33.54 deg. Injection velocity was 25,728 fps., only 8 fps. over predicted.

The astronaut underwent 8g loads during launch and re-entry. The flight went precisely according to its program from the 9:47 a.m. launch until about 11 a.m., when the 1 lb. thrust right yaw reaction jet failed to keep the capsule oriented. When the capsule drifted to 20 deg. right yaw, the 24 lb. thrust reaction jet compensated and brought the capsule back to zero.

The problem became pronounced when the capsule was approaching the Guaymas, Mexico, tracking station, and from this point through re-entry, Col. Glenn manually controlled the capsule, either in the fly-by-wire link through the autopilot, or through the manual proportional system. Full manual system was used to damp oscillations throughout the capsule's re-entry maneuver, and to orient the capsule for re-entry.

Throughout the flight, despite the added stress of continuous control, Col.

Glenn recorded his observations, took 128 color and black and white pictures with a 35 mm hand camera, re-set his time-to-retrofire clock three times and transmitted standard report every 30 min. He ate one meal early in his first orbit. It consisted of semi-solid applesauce, a beef vegetable mixture and malt tablets. He observed thousands of tiny luminescent particles at each sunrise and turned his capsule 180 deg. so he could follow them. The particles have become known as the Glenn Effect and the most consistent theory is that they are vapor particles from capsule reaction jet and environmental systems which froze and reflected sunlight.

False Signal

Most critical part of the MA-6 mission occurred when a faulty switch resulted in an erroneous signal that the heat shield was loose. Flight controllers had to assume that the shield was loose and to take corrective action.

The problem with the automatic control system was easily overcome, because there are four methods to control capsule attitude. Possibility of a loose heat shield was completely unexpected. There were immediate conferences with engineers who had conducted wind tunnel studies on the capsule early in the program, and in a matter of minutes a solution was found. The package housing deceleration rockets, used to provide clean separation from the launch vehicle and deceleration rockets to take the capsule out of orbit, normally is jettisoned immediately after the deceleration rockets are fired.

It was decided to keep this package strapped to the shield to secure the heat shield to the capsule. It was theorized that by the time the titanium straps holding the package were burned through by re-entry heat there would be enough atmosphere acting on the shield to keep it seated against the capsule.

The shield forms the base of the landing impact skirt and drops at the same time the main recovery parachute deploys at an altitude of 10,000 ft. as the capsule descends after flight. The impact skirt is rubber-nylon material, four feet long.

USAF Maj. Donald K. Slayton is the pilot designate for MA-7, and all Mercury pilots have been assured at least one flight in the program. Specific missions have not yet been assigned for Cdr. Walter M. Schirra, Lt. Cdr. Scott Carpenter and Maj. Gordon Cooper.

NASA expects to augment its astronaut roster this month, and to retain the original seven Mercury pilots for 18 orbit flights and Gemini and Apollo flights.

WALTER G. WILLIAMS, Project Mercury operations director, explains Feb. 20 weather pattern to Dr. Hugh L. Dryden (left), NASA deputy administrator, shortly before launch of Mercury-Atlas-6. At right is Robert R. Gilruth, Mercury director.

SIMILARITY between Sputnik 5 capsule (left), used to orbit two dogs successfully 18 times, and Vostok cabin seat (right), which carried Yuri Gagarin on one orbit, is evident in angles of forward bulkheads and conduits along sides of the seats.

Soviet Union Plans Multi-Man Spacecraft

By George Alexander

Soviet Russia is expected to maintain its lead over the U. S. in manned space flight this year by launching the multi-man spacecraft that it eventually will use for circumlunar flights and lunar landings

Russia can also be expected to take advantage of astronomical conditions this year to send instrumented "space laboratories" to Mars and Venus.

Venus on August 16 will be in the most favorable position for a shot from earth since January of last year, a few weeks before Russia pioneered the launch-from-orbit technique by sending a probe toward this planet from a 7-ton vehicle orbiting the earth (AW Feb. 20, 1961, p. 26). Mars will be in the best position Nov. 16 for a launch from earth since Oct. 1, 1960.

Bioastronautics experts in the U.S. consider it highly probable that Russia before attempting circumlunar flights, will use more one-man flights or take advantage of a multi-man capsule to investigate in more detail the phenomenon of weightlessness—perhaps answering some of the many questions raised by Maj. Gherman S. Titov's reactions in his 25-hour orbital flight.

Although Russia has not revealed any space shots leading toward further investigation of the moon since the series of three launched in 1959, there is little doubt that it plans a program of lunar exploration similar to that of the U.S.

Flights Outlined

Late last year, a number of Russian publications printed the broad outline of plans for circumlunar flights, landing of instrument packages, manned landings, and "establishment of a permanent scientific station on the moon and ultimately ... an industrial-type installation."

Then, the articles said, will come flights from the moon to the nearest planets of the solar system—Mars and Venus—flights which may well be made within the next few years (AW Jan. 8, p. 26).

Russia mounted the first rung of the manned space flight ladder ahead of the U.S. last year with the 1-orbit flight of Maj. Yuri Gagarin in April and Titov's 17-orbit flight last August.

Although the U.S. sent Astronauts Alan Shepard and Virgil I. Grissom on ballistic space trajectories in 1961, it did not achieve orbital flight until Lt. Col. John Glenn's 3-orbit flight Feb. 20, 1962. Russia can be expected to press the great time advantage it has gained by an earlier start and because of minor problems and delays in the U.S. Mercury program.

Some U.S. observers believe the Soviet Union may have planned, had Titov's flight proved to have been as successful as Gagarin's, to proceed directly to launch of a multi-man spacecraft on a circumlunar mission.

GHERMAN TITOV undergoes physiological checks prior to his flight

Success Questioned

That the second Soviet space pilot's flight may have been something less than a complete success would appear possible from the frequent attention given in recent months by the Russians to the still unsolved problems of manned space flight technology, particularly weightlessness.

U.S. observers are divided on whether weightlessness problems posed by Titov's flight could be a prime factor in explaining the absence of recent Soviet space activity, but are generally agreed that it would be unwise to assume that apparent Soviet inaction signifies Soviet problems.

Period of Review

Some believe this period of inactivity is a normal interval of assessment, review and preparation leading to the next major milestone. This group doubts that the Soviets are as concerned with weightlessness as a reading of current Soviet material might lead one to believe. It also thinks the Soviets believe problems of weightlessness that affect a pilot's performance can be solved on a concurrent basis and that there may be something else—perhaps burst energies required for the lunar landing mission—that is receiving closer Soviet scrutiny.

Another U.S. school of thought regards the cautionary notes being sounded in present Soviet literature as an accurate barometer of conditions within the Soviet scientific community and believes that USSR scientists are

Firing, Planetary Shots Next

SPACE SUIT, pressurized and insulated, was said to be worn by Soviet pilots during their two orbital flights

generally worried about weightlessness.

Both U. S. groups think it more than likely that the Soviet Union will fly multi-man spacecraft in earth orbits this year and that the crew might include a medical researcher to monitor directly the reactions of other crew members to extended periods of zero-g. Opinion is divided on whether the primary objective of the flight would be to test the basic Soviet circumlunar and lunar landing spacecraft or to extend weightlessness research.

Recently, three Soviet scientists—Professors Vasili Parin and Vladimir Yazdovsky and Dr. Oleg Gazenko—reported to the USSR Academy of Medical Sciences that more research is needed to determine if certain physiological functions can be replaced by others while a pilot is in a zero-g environment. The report also noted that the absence of a gravitational field resulted in a reduction, or exclusion, of the activity of the otolith receptor in the internal ear—an organ which provides a sense of balance and orientation.

Airsick Cosmonaut

The three-man report paralleled a paper presented to the 12th annual International Astronautical Congress in Washington last October by Yazdovsky and Gazenko (AW Oct. 9, p. 22). At that time, the two Soviet scientists said Titov experienced trouble with his vestibular apparatus (inner ear) and that the resultant discomfort was akin to air or seasickness.

The scientists said they believed that the exclusion of the otolith receptor resulted in the body attempting to compensate for the loss of this stimulus by overloading the semicircular canals within the ear. Otoliths are small particles of calcium carbonate on the ends of very small fine hairs within the ear; gravity or movements of the head cause these particles to move and the motion is sensed and transmitted to the brain by sensitive nerve ends at the hair roots. The semicircular canals are small tubes each in a different plane, which also provide inputs to the total vestibular apparatus.

With the otoliths not functioning, the Soviet scientists theorized, the body demanded more inputs from the canals, which became irritated. Irritation then led to "extreme reactivity, violation of coordination, and to development of a seasickness syndrome."

Verification Needed

While this explanation seems reasonable the scientists said, it would require experimental verification and more precise definition. From a practical viewpoint, they said, the nervous system is characterized by a compensatory flexibility "which makes it feasible to restore the lost contact with the outer word by means of substituting one function by others." Whether this principle can be extended to the case of weightlessness, the Soviet scientists said, will depend on actual experimentation.

This mention of a need for further orbital flights to ascertain whether Titov's troubles in a zero-g environment were unique or generic, is not new. Last September the newspaper Pravda said that future spaceships may have to be provided with artificial gravity if subsequent investigations show that other space pilots also experience vestibular difficulties.

The USSR might experiment with various artificial gravity devices in the next phase of its flight program. Yazdovsky, while in Washington for the Astronautical Congress, suggested that drugs might be used to alleviate the more adverse effects of weightlessness. He likened the use of drugs in spaceflight to those used commercially today to counter air or seasickness.

Other areas of artificial gravity that could be explored are magnetic space suits in which the pilot would have to exert some force to move about the ship, or mild electrical stimulus to the inner ear.

The problem of extended zero-g is of critical importance to the roles being

evolved for space pilots by both the U. S. and USSR. Titov, for example, had to restrict his head movements to eliminate feelings of dizziness and nausea. Intensity of these reactions diminished as he held his head in a fixed position and after he had slept, but they did not disappear completely until the retrorocket system had been turned on and provided a positive g force.

Soviets emphasized that Titov's vestibular troubles did not affect his working ability. The fact remains that the tasks assigned to the second USSR cosmonaut were fairly minimal—eating, sleeping, writing, observing, controlling the ship and some calisthenics—and did not require extensive use of the body.

The role of repairman, however, would demand that a space pilot be able to move freely about a spacecraft. If vestibular troubles restricted his head movements to preclude disorientation, his effectiveness would be considerably reduced.

Seven Soviet space flights, beginning with Sputnik 2 in 1957 in which a dog was placed into orbit, culminated April 12, 1961, when Maj. Gagarin made the world's first manned orbital flight. The Vostok spacecraft's orbital parameters closely approximated those of Sputniks 6 through 10—perigee of 108.76 mi., apogee of 187.66 mi. and period of 89.1 min.—lending credence to the frequent Soviet claims of precise guidance systems.

Aside from cardiac fluctuations, which were expected and which were well within limits of normal strain, Gagarin reported that he experienced no difficulties (AW Apr. 17, p. 26). At the time, Soviet scientists were quoted as saying that if post-flight examinations revealed that Gagarin had suffered no ill effects, more manned space missions would follow shortly.

On the morning of Aug. 6, 1961, Maj. Titov was launched in a second Vostok spacecraft on an orbital flight that was to last for 25 hr., 18 min. The flight profile was very similar to the 18 orbit flight of Sputnik 5 of the previous year.

Titov's launch vehicle lifted off at 9 a.m., Moscow time, according to the Soviet news agency Tass. Once in orbit, Titov said his initial impression was that he was flying with his feet up, but that this feeling soon left him.

Within an hour after liftoff, the pilot exercised the spacecraft's manual control system and reported that "it was easy and convenient to control the ship. It was possible to put it into any predetermined position at any moment and to orient it to the necessary direction." He again switched the mode of control from automatic to manual during the seventh orbit.

During the second orbit, telemetered data indicated that his pulse was 88 beats per minute and his respiratory rate 15-18 breaths per minute.

He ate lunch at the end of the third orbit, roughly the noon hour, squeezing food from toothpaste tube-like containers. In the course of his day in space, Titov consumed three meals—lunch and supper on the day of launch and breakfast on the day of recovery. Food consisted of soup puree, chocolate, meat and liver pastes, small pieces of black bread, juice and water.

The water was carried in a small tank and drunk through a mouthpiece and tubing.

He confessed later that he had not had much appetite for food, but "in myway to conform to the program established for him." His lack of appetite probably was due more to the feeling of nausea induced by his inner ear difficulties than to any true disinterest in eating.

In the fourth orbit he rested and did some calisthenics. Beginning the sixth orbit, he reported that "cabin pressure is constant, humidity is 70%, the temperature 20 degrees (centigrade). Complete comfort."

At about 5 o'clock in the afternoon, Moscow time, or halfway through the sixth orbit, Titov ate supper. Midway through the seventh orbit, Titov was scheduled to go to sleep for 7.5 hr.—

IN-FLIGHT VIEW through Vostok observation port reveals some details of the port, consisting of mirror reflectors, light filter and glass with grid.

from 6:30 p.m. Aug. 6 to 2 a.m. Aug. 7, Moscow time.

Approximately one month after Titov's flight, the newspaper Pravda reported that the pilot's sleep, especially at first, was restless. The newspaper also said that his pulse rate asleep was 54-56 beats per minute; the news agency Tass gave the figure of 53-67 beats per minute.

The pilot overslept by 37 min., awakening at 2:37 a.m. He breakfasted at 5:45 a.m. and began his fifteenth orbit at about 6 a.m. Moscow time. By 8:20 a.m., Moscow time, the Vostok 2 vehicle was starting into its seventeenth orbit with the re-entry sequence scheduled to begin at about 9:48 a.m. at the start of the eighteenth orbit.

Pravda said the re-entry sequence was initiated by the Vostok's automatic orientation system, which scanned the earth's horizon and the ship's reference to the sun after the spacecraft had passed from the earth's shadow. One Soviet illustration showed the Vostok turned 180 deg.—facing rear first—for retrofiring.

"Finally," the newspaper article continued, "the braking motor was turned on. The space ship changed over to a descent trajectory."

The Soviets have said that a pilot has the option of using one of two landing systems. In the first, which Gagarin employed, the pilot remains within the spacecraft and lands with it. Whether the vehicle has control surfaces or whether the entire vehicle is lowered by parachutes has never been made clear by the Soviets.

Titov, the Soviets say, used the second method of landing, which involves ejection of the pilot's seat from the spacecraft at an altitude of about 20-25,000 ft. and final descent by parachute. The flight ended at 10:18 a.m. Aug. 7 when Titov touched down near the village of Krasnyi Kut in the province of Saratov.

Separation Devices

The pilot's seat, according to the newspaper, contained "devices which ensure the cosmonaut's automatic safe separation from the space ship and his landing in the event that an emergency situation should arise in the craft during launching or entry into orbit."

The seat, the supporting surfaces of which were lined "with light plastic cushions shaped to conform to the body contours resting against them," also carried:

- Oxygen supply and an air-conditioning system for pilot comfort
- Radio transmitters and receivers
- Food supplies
- Emergency equipment for use after landing

Vostok 2, according to Pravda, consisted of a pilot's cabin, an instrument compartment and a braking power (retrorocket) compartment. The Vostok 2 cabin was equipped with heat-resistant

glass ports through which Titov made observations and took photographs with a small movie camera during orbit and on the downward leg. The pilot also was provided with a 3- and 5-power periscope through which he could make observations.

Titov's descriptions of the earth and sky, as seen by him, do not differ markedly from those reported by Gagarin. He said that the horizon was encircled with a soft blue aureole and, as the ship came out of the earth's shadow, he saw the world girdled with a bright orange belt.

"Sunshine came in through the ports and it was so light in the cabin that I could switch off the lights," Titov said.

When there was no sunshine . . . I could observe at the same time both the sunlit earth and the stars—clear bright points on a very black background."

The cabin was sheathed in a "thermal shield," Pravda said, to protect the pilot from the extremely high temperatures of re-entry and was equipped with two "snap-action manholes," presumably escape hatches similar to those of Mercury capsules.

Within the cabin were life support systems equipment, controls, some radio equipment, a log book, the periscope and television cameras.

Parallel Transmitters

Academician V. A. Kotyelnikov said that Vostok 2 carried two parallel high-frequency (HF) AM transmitters, broadcasting on 15.765 and 20.006 mc. over a common antenna through special filters. The spacecraft also carried a very high frequency (VHF) FM transmitter broadcasting on 143.625 mc. over a special antenna. The VHF radio link was used only when the Vostok was passing over the Soviet Union. Kotyelnikov also said that Titov had a telegraph key, but that he did not use it because of the high quality of the voice transmissions.

The spacecraft also contained a tape recorder and two television cameras, one narrow band and one wide band. The narrow band unit had a definition of 100 lines, the second unit—new and flight tested for the first time—had a definition of 400 lines. Both systems transmitted 10 pictures per second.

At ground stations throughout the USSR, motion pictures were made of the television monitors and synchronized with the recording of telemetered physiological functions, such as pulse and respiration rates, electrocardiogram etc. Soviet scientists were thus able to compare Titov's body functions with his facial reactions during stress periods in the flight profile.

The tape recorder automatically turned on whenever the pilot spoke. Passing over the Soviet Union, the recorder transmitted the tape's contents over the VHF system at a speed seven times greater than the recording speed.

All ground stations in the USSR were linked with a central dispatcher, at a location not identified by Pravda. According to the article, "He gives orders when to turn on a certain transmitter and specifies what must be transmitted to the spaceship. All the information from the ground receiving stations flows to him."

Vostok 2 contained a new oxygen regeneration system that differed from the one used by Gagarin in structure, chemicals, and improved design. Variations in the oxygen, carbon dioxide and water vapor contents within the spacecraft were detected by special sensors. Outputs of these sensors were fed to automatic regulators, which then corrected the imbalances. Titov also had a manual control which could override the regulators in selecting the balance he wanted. Humidity was kept between 50-70%.

Temperature control was maintained both by the pilot's manual control and by a thermostat. The thermostat consisted of two circuits: an air unit open to the ambient temperature within the cabin and a closed liquid circuit installed in a radiator in the cabin's instrument bay. Both circuits were coupled in an air-liquid heat exchanger within the cabin. Temperature throughout the flight of Vostok 2 was maintained between 10 and 25C.

Vostok was designed, the Russians said, to operate for periods longer than Titov's 25-hr. flight and carried sufficient quantities of food, water, oxygen and electrical power for longer flights. Titov later told a conference that the spacecraft had been designed to carry one man. Asked whether the spacecraft could be used for interplanetary flights, Titov replied that the vehicle was intended for orbital flights. M. Keldysh, president of the USSR Academy of Sciences, added that the design of the space ship can be further improved for successful interplanetary flights, implying that Vostok is a basic design which can be expanded to meet varying mission requirements. Some U.S. observers believe that Soviet multi-man spacecraft will be growth versions of the Vostok, similar to the development of the two-man Gemini vehicle from the Mercury single-seater capsule.

Titov was dressed in woolen underwear over which he wore a blue spacesuit and, over that, a bright orange flying coverall with the letters "USSR" stenciled on the back. The suit was ventilated with cabin air and was so well insulated and airtight that had the pilot landed in water he could have remained afloat for 12 hr. at 0 C without discomfort. His helmet was a large globe, under which he appears to wear a soft cap similar to those worn by World War 2 pilots. The large glass visor across the face can be opened and closed manually, but closes automatically in the event of cabin pressure failure or an increase in the cabin's carbon dioxide content.

Soviet literature has been making frequent comment on emotional tension as one of the many important factors affecting a pilot's physiological reactions to space flight. Pravda quoted Titov as saying at a conference Aug. 11:

"Overstrains [accelerations], noise and vibration during the takeoff segment of the flight were borne well and without unpleasant sensations. During this stage of the flight, I carried on observations through the portholes and watched the instruments. I maintained two-way radio communications with earth."

The newspaper then commented:

"True it should be pointed out that despite such a good general subjective condition [report] on the part of the cosmonaut, it was observed that his pulse rate increased somewhat and reached 118-134 beats per minute."

During the countdown, Pravda noted that, "At this time, small variations in the respiration rate and increased heart contractions to 90-106 beats per minute were observed. One minute before launch, the pulse rate reached 120 beats per minute. Undoubtedly, the variations noted had an emotional origin."

Although Pravda said in one paragraph that these fluctuations did not exceed the limits recorded on Titov during training, it said in a subsequent paragraph that the pilot's pulse rate of 80-100 beats per minute during flight "somewhat exceeded original estimates." Parin Yazdovsky and Gazenko, in their paper, noted that pulse and respiratory rates, as well as other physiological indexes, taken on their two orbital pilots during flight, considerably differed from the data taken during centrifuge ground tests.

Space Activities Summary

Year	Success	Wt (lb.)	Failure*
1957	Sputnik 1	8,000	Vanguard TV3
	Sputnik 2	8,000	
1958	Explorer 1	30.8	Explorer 2
	Vanguard 1	55	Explorer 5
	Explorer 3	31	Vanguard TV3A
	Sputnik 3	7,000	Vanguard TV5
	Explorer 4	38.4	Vanguard SLV1
	Pioneer 1 (Probe)		Vanguard SLV2
	Pioneer 2 (Probe)		Vanguard SLV3
	Score	8,750	
1959	Luuk 1	3,245	Vanguard SLV5
	Vanguard 2	73	Vanguard SLV6
	Discoverer 1	1,300	Discoverer 3
	Pioneer 4	13.4	Discoverer 4
	Discoverer 2	1,600	Explorer
	Explorer 6	142	Beacon 2
	Discoverer 5	1,700	Transit 1A
	Discoverer 6	1,700	Atlas Able 4
	Luuk 2	858.4	
	Vanguard 3	100	
	Luuk 3	4,037	
	Explorer 7	91.5	
	Discoverer 7	1,700	
	Discoverer 8	1,700	
1960	Pioneer 4	94.8	Samos 1
	Tiros 1	270	Midas 1
	Transit 1B	265	Courier 1A
	Discoverer 11	1,700	Discoverer 9
	Sputnik 4	10,008	Discoverer 10
	Midas 2	5,000	Discoverer 12
	Transit 2A	223	Discoverer 16
	Greb	42	Echo
	Discoverer 12	1,700	Explorer
	Echo 1	240	Radiation Satellite
	Discoverer 14	1,700	Atlas Able 5A
	Sputnik 5	10,120	Atlas Able 5B
	Discoverer 15	1,700	Transit 3A/Greb
	Courier 1B	500	Scout 3
	Explorer 8	90	
	Discoverer 17	2,100	
	Tiros 2	280	
	Sputnik 6	10,060	
	Discoverer 18	2,100	
	Discoverer 19	2,100	
1961	Samos 2	4,100	Explorer S-45
	Sputnik 7	14,282	Discoverer 22
	Sputnik 8	1,419	Mercury-Atlas 3
	Explorer 9	80	Explorer S-45A
	Discoverer 20	2,450	Discoverer 24
	Discoverer 21	2,200	Explorer S-55
	Transit 3B/Loftr	307	Discoverer 27
	Sputnik 9	10,340	Discoverer 28
	Explorer 10	79	Samos 3
	Sputnik 10	10,330	Discoverer 33
	Discoverer 23	2,100	Mercury-Scout 1
	Vostok	10,418	
	Explorer 11		
	Discoverer 25	1,700	
	Transit 4A/Injun/SR-3	270	
	Discoverer 26	2,100	
	Tiros 3	285	
	Midas 3	3,500	
	Vostok 2	10,434	
	Explorer 12	83	
	Ranger 1	675	
	Explorer 13	127	
	Discoverer 29	2,100	
	Discoverer 30	2,100	
	Mercury Atlas 4	2,700	
	Discoverer 31	2,100	
	Discoverer 32	2,100	
	Midas 4	3,500	
	Discoverer 34	2,100	
	Discoverer 35	2,100	
	Transit 4B/TRAAC	400	
	Ranger 2	675	
	Mercury-Atlas 5	2,800	
	Discoverer 36	2,100	
	Oscar	10	
1962	Ranger 3	727	Discoverer 37
	Tiros 4	285	Composite 1
	Mercury Atlas 6	2,987	Echo 2
	Discoverer 38		

* USSR has not announced failures in its space program

MARTIN-MARIETTA/ARMY PERSHING selective combat range artillery missile, in a configuration close to its operational one, is fired in an extended range test at Cape Canaveral.

Missiles

AEROJET 500,000-LB SOLID ROCKET FIRING

Missile Development Emphasis to Shift

Operational status expected late this year for Minuteman, third USAF intercontinental ballistic missile to reach combat readiness, will mark a shift into a new gear for U. S. missile research and development.

Complemented by the Polaris fleet ballistic missile on station in nuclear submarines, USAF ballistic missile strength will be divided into Atlas and Titan liquid propellant missiles in semi-hardened coffin or fully hardened silo complexes, and the solid propellant Minuteman which will be dispersed in holes over wide areas.

Development effort is shifting to:

- **Titan 2**, a storable propellant version of Titan 1 designed for advanced performance and quick reaction time.
- **Titan 3**, which utilizes a Titan 2 core augmented with two 120-in. solid propellant motors strapped to its side. Titan 3 could have the capability for launching warheads of increased size in a ballistic trajectory as well as its prime mission of placing a variety of payloads into orbit.
- **Mobile mid-range ballistic missile**, projected as a truck-carried weapon capable of being based randomly about Europe. It could also be ship-based.
- **Skybolt** air launched ballistic missile, designed for firing from the Boeing B-52H turbofan powered bomber. Skybolt also will be carried by British Vulcan bombers, and in this sense represents an effort like the MMRBM to broaden missile capabilities of U.S. allies.

Of these, only the MMRBM contractor is yet to be chosen, and prospective $2.5 billion size of the program will stir keen industry bidding.

Six groups of potential associate contractors—for propulsion, guidance, command and control, transporter launcher, re-entry vehicles, and integration, assembly and checkout—will compete for separate development categories of this system.

Under its strategic concept, the missile probably is to be fired from any location within 15-min. readiness time on launchers designed to rove highways, secondary roads and town and village byways in NATO nations for whose use the weapon system would be developed.

Political and strategic considerations are integral parts of the program.

- **Department of Defense and Pentagon** strategists generally favor the concept of this 200-2,000 mi. range solid propellant rocket, but lower echelons of the Air Force are not enthusiastic about the over-all development ramifications and deployment difficulties.
- **Presidential and State Department** policy is involved because of the international implications of NATO use of a nuclear warhead, requiring congressional approval. There are international considerations, among them the pros and cons of providing West Germany with a nuclear fist. France has strong views against providing this capability, and also wants to develop its own nuclear capability. Undoubtedly, joint command and control by foreign and U. S. commanders would be essential.
- **Navy participation** in the program probably as a result of direction by the Secretary of Defense, could introduce inter-service complications. Navy use probably would see the weapon adapted for deployment on Merchant Marine and naval vessels, positioned at the stern in an orange-peel cocoon fitted with environmental controls and fast-action opening for missile launch. A Navy captain already is assigned to BSD for inter-service liaison.

Industry observers also feel there is a possibility of participation by the Army in the development of the transporter-launcher.

Roots of the MMRBM program stem from SR-19872 (AW Jul. 18, 1960, p. 26) under which studies were made for a small ICBM unofficially referred to as Midgetman or Shrimp. Participants in this study are likely to have a strong position in the MMRBM competition.

Design Challenge

Design of the transporter-launcher will have to involve an ingenious approach to accommodate all the support functions for the MMRBM. Complete environmental controls, including an easily accessible cocoon shelter for the missile, will have to be provided to supply temperatures and humidity compatible with long-time alert periods for the weapon.

An array of auxiliary gear and consoles also will be needed.

Since estimates are that the solid propellant missile won't exceed 25 ft. in length, the transporter-launcher as an envelope likely will be tailored fairly close to this dimension. As a wartime

weapon shelter, the transporter-launcher probably will have to incorporate a fair degree of blast protection for the missile and the associated equipment it carries.

Acoustical protection also will have to be incorporated to ensure that surrounding noise level does not cause missile propellant ignition—a precaution incorporated in existing fixed-site ICBM systems. To support a 25-ft-long missile and associated equipment, this transporter would have to weigh about 16,000 lb. As a vehicle for a mobile missile, it would need reasonable cruise speed capability and be able to haul its load up a substantial grade.

Probable Staging

General configuration probably will resemble the Minuteman ICBM, but would have two stages instead of three. Range selection would be controlled by thrust cutoff provisions in the upper stage. Booster stage length of more than 9 ft. and diameter of more than 4½ ft. is unlikely. Second stage would be about half as long and slightly smaller in diameter. Remainder of the length would be allocated to interstage fairing, guidance section and re-entry vehicle, which necessarily would be small in comparison with existing ICBM warheads. Single nozzles are probable in each stage with fluid injection for thrust vector control.

Army had advocated an extended-range version of its Pershing selective combat range artillery missile as an alternative to the mobile missile concept, but lost.

Pershing, under development at Martin Marietta's Orlando Division, also will be deployed overseas—initially with U.S. Army units. West Germany has ordered the solid-propellant weapon instead of the Martin air-breathing Mace it originally planned to buy, and other NATO nations may do so as well.

Introduction of Pershing into field units is expected to begin late this year as development firing tests are completed at Cape Canaveral. It will replace the liquid-propellant Redstone.

Three Pershing configurations were used in 19 test launchings last year. The most obvious change was to a long nose which gradually tapered to a sharp point. This configuration was necessary to house test instrumentation, new warhead shape and an inertial guidance system. A fourth and latest configuration, which appeared in test firings early this year, has a somewhat shortened version of the long nose shorter because of removal of research and development instrumentation.

Firings this year will be using the complete Pershing ground handling system: a transportable erector-launcher carried on an XM 474 prime mover, a primary power and fire control unit or hut—in effect, a portable blockhouse—carried on a second XM 474, a communications hut carried on a third XM 474 and a warhead and spares hut carried on a fourth XM 474.

Field operation of Pershing calls for a 12-min. firing sequence, including backing the warhead carrier to the missile for mating, and erection and aligning. The full sequence has been carried out in the plant, but only the mobile launcher and XM 474 carrier have been used in actual firings at Cape Canaveral.

Navy's Polaris fleet ballistic missile also was proposed for West German or NATO use. Though Polaris conceivably also could have filled the MRBM requirement, the task of adapting this weapon to a rugged land environment appeared to be more difficult than adding to Pershing's range.

Polaris with Lockheed Aircraft as contractor, still is absorbing the biggest part of Navy's missile effort.

Despite inability to use the high temperature propellant on which early calculations were based, the most advanced Polaris, A-3, is expected to meet its 2,500 naut. mi. range specification because the goal of the development program was well beyond that figure.

Specific impulse of a propellant is highly dependent on its combustion temperature. Aerojet-General Corp., Polaris propulsion contractor, is working on a synthetic nitropolymer propellant developing approximately the 6,600F theoretical flame temperatures attributed to the propellant originally planned for A-3.

The missile will burn a lower rated propellant, not because development of the new formulation is behind schedule, but because existing nozzle materials are incapable of surviving the high temperature. This problem is compounded in the big solids being proposed—120 in. diameter and greater. Developers are understood to be considering ablating nozzle materials as a solution.

Grain Design Gain

Part of the increased performance of the Polaris A-3 will be obtained from a new grain design which gets a somewhat larger volume of propellant into the case. Together with a reduction in the weight of inert parts, this improves the propellant mass fraction of the missile.

Polaris A-3 will have a fluid injection thrust vectoring system, using Freon, which will improve nozzle efficiency, increase reliability and probably reduce the weight of inert components. Polaris A-3 components are being flight tested individually using A-2 missiles and complete A-3 system tests will begin later in the year.

Navy is broadening deployment of Polaris submarines. Because of increased range of the A-2 and A-3 versions and because of the rising number of operational submarines, a force of them will soon be on station in the North Pacific on a regular basis. To provide a logistic center for this force, Navy is establishing a naval weapons annex at Bangor, Wash. The East Coast equivalent at Charleston, S.C., has been operating on a routine basis for many months.

In the Fiscal 1963 budget the Administration is asking Congress to increase to 35 the number of completely funded nuclear fleet ballistic missile submarines. Also included in the budget is procurement funding for long lead time parts for six more.

Navy is moving to meet the threat of improved Soviet ASW and anti-missile capability, though neither is expected to materialize for some time. Anti-missile defenses will be countered by radar decoys already being developed for Polaris. To counter sonar techniques and growing knowledge of oceanography, Navy is conducting a stringent submarine silencing program to minimize the usefulness of Soviet passive listening techniques.

High Sound Levels

Even so, the large amount of energy dissipated in the sea by a large body moving at high speed is certain to produce relatively high sound levels and the explosive release of compressed air as each missile is launched is easily detected at great range. Navy is working on the development and tactical application of acoustic counter-measures aimed at confusing Soviet interpretation of these sounds.

A solid propellant missile, the Minuteman ICBM, is, like Polaris for the Navy, the biggest missile item in USAF's Fiscal 1963 budget request. Readiness of the first Minuteman silo launcher late this year at Malmstrom AFB, Mont., will mark the beginning of an operational buildup in which the Montana sites are ahead of schedule.

Besides the 12 squadrons previously planned, four more squadrons—normally five flights of 10 silos each and one launch control center—are included in the Fiscal 1963 budget. These four squadrons, whose strength may be altered from the five-flight pattern, may be located within 100 mi. of Malmstrom, probably as part of that complex.

Decision to seek the four additional squadrons was made simultaneously with the decision to cancel the mobile Minuteman because its benefits were judged not to be worth the expense, which would exceed the fixed-base version. Also, the mobile version, on railroad cars, would be more expensive to operate, less reliable, less accurate, and more susceptible to sabotage.

Minuteman Buildup

Four Minuteman wings committed—Malmstrom AFB, Ellsworth AFB, S.D., Minot AFB, N.D., and Whiteman AFB, Mo.—will comprise 600 missile launchers. A fifth wing is contemplated and may utilize a growth version of the missile. It may consist of an all-glass fiber airframe, propellants of higher specific impulse and a second generation inertial guidance system. (AW Oct. 16, p. 28).

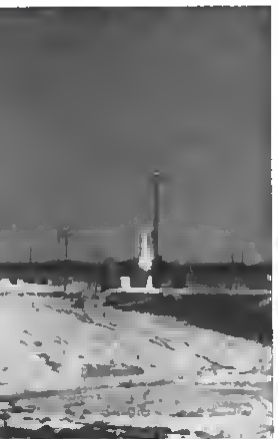
Flight test program for Minuteman, centered at the Atlantic Missile Range, is affording verification of the silo launch technique. The installation uses automatic sequencing equipment from the time the signals are given to initiate the launch. This portion of the ground system and the silo environment are considered completely proven.

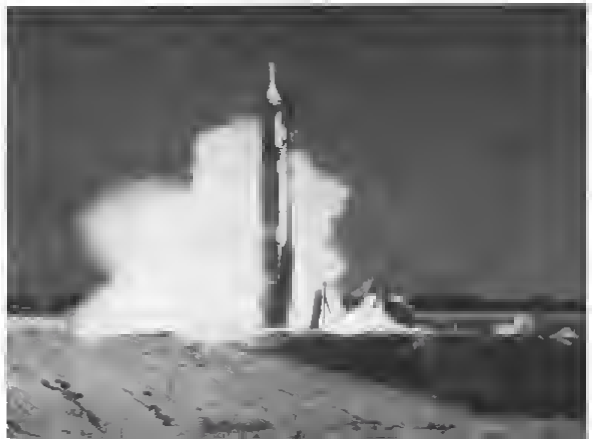
First three Minuteman launches at Cape Canaveral were from a pad, and two were considered successful. The fourth launch, Aug. 30, 1961—first from the Cape Canaveral silo—was a failure. Just as the missile blasted out of the hole, the second stage ignited and exploded. Succeeding launches from the silo, Nov. 17 and Dec. 18, 1961, Jan. 5, Jan. 25, and Feb. 15, 1962, all were successful. No acoustic, shock or heat problems of any consequence have been encountered, and launch schedule at the Cape will be accelerated.

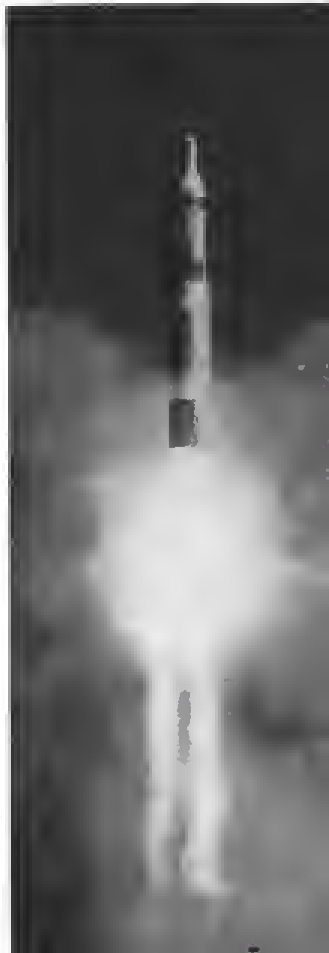
All flights have been with virtually an operational configuration. Addition of test instrumentation, contained in a compartment raised 18 in. above the guidance section, adds hundreds of pounds of weight which, with the operational payload weight carried on several flights, exceeds design requirements.

Greatest range attained was 4,600 mi.

TITAN 1 SILO LAUNCH FIRING SEQUENCE







MINUTEMAN TRANSPORTER-ERECTOR

on the first launch. Various test objectives account for subsequent ranges from 3,200-3,900 mi. But range is not now a prime objective, nor was it in the Atlas or Titan initial test programs.

Boeing Co., Minuteman assembly and test contractor, has the launch control system and some ground power equipment under systems test. Later, the complete ground system will be put through its proof test, followed by final missile systems integration.

Weapon system final demonstrations will take place at Vandenberg AFB, Calif., where six Minuteman training silos eventually will be available. The 6595th Aerospace Test Wing (DCAS) at Vandenberg received in December, 1961, the first "handling" Minuteman missile for ground equipment checkout. On Jan. 22, the missile was lowered into its silo with the transporter-erector. Later this year, the test wing is scheduled to fire an R&D missile, with a Strategic Air Command crew integrated into the operation.

At Hill AFB's Logistics Command Depot, Ogden, Utah, a surveillance program is gathering data on the longevity of the missile in the silo, expected to be measured in years. Partially completed and complete engines are stored in a controlled environment which duplicates silo conditions. Periodically, engines will be removed and fired to determine whether storage has affected them. Also at Hill is Air Force plant 77, which Boeing will operate as an assembly and re-cycling facility. Engines have been put through thousands of miles of road tests to check their ability to withstand vibration, shock, handling, and miscellaneous movement.

In another segment of the development spectrum is Titan 3, designated as Program 624A at Air Force Systems Command's Space Systems Division. The programed configuration—two 120-in. diameter solids clustered to a Titan 2 core—is not the final configuration. Probability is that Space Systems Division will proceed with the development of a 156-in. solid propellant motor to produce a substantially higher base thrust. There is the additional probability of capping Titan 2 with a high-energy stage burning fluorine-hydrazine, fluorine-hydrogen, or hydrogen-oxygen propellant combinations.

Weapon system payload capability of Titan 3, using two five-segment solid-propellant first stage boosters, is indicated by its estimated performance ability to launch a 32,000 lb. payload over the Atlantic Missile Range into a 150-mi. orbit, or a 29,500 lb. payload into a 300 mi. orbit. The Atlas ICBM places about 1½ tons into 100-160 mi. orbit in the Mercury program.

Titan 3's projected flight date is late 1964 or early 1965. Development emphasis will be on a configuration of four

center segments and two end caps, but growth to a five-segment motor will be included in the development plan.

Titan 3 Size

Industry estimates are that the four-segment configuration will weigh approximately 375,000 lb, and the five-segment 450,000 lb. Total length of a five-segment motor, including a nozzle about 10 ft long, probably would not exceed 75 ft—slightly more than the first stage of the Titan 2 core.

Higher-than-normal specific impulse propellants, probably 260 sec, will be sought for the 120-in. motors. Fluid injection for thrust vector control probably will be used because this line of development is receiving emphasis in research with almost all major solid-propellant manufacturers.

Mating of the two 120-in. solids to the Titan 2 core should not be a difficult problem. Structural reinforcement for the core will be required at the attachment points of the solid casing and additional strength weight will involve about 2,800 lb for the first stage of Titan 2, approximately 550 lb for the second.

Development of a 156-in. solid propellant motor for Titan 3 probably will proceed on a very limited basis in the initial phases. Thrust of a five-segment, 156-in. motor may be about 1,800,000 lb, with a burning time of more than 80 sec. The five segment, 120-in. motor would produce 1,350,000 lb thrust, and have a burning time of approximately 100 sec.

Titan 2 Firing

First static, sequential, compatibility firing of the storable propellant Titan 2 was made at Martin-Denver, the prime contractor's facility, in late December, 1961. The two stages were positioned side-by-side, with Stage 1 firing first and Stage 2 cut in to simulate flight conditions, a carryover from testing techniques used for Titan 1. First Titan 2 (N-2) is at Cape Canaveral and is scheduled to be fired sometime this month.

Tempo of Titan 2 testing will be accelerated and will exceed the pace of the Titan 1 test program, which has involved approximately 50 firings. Technology amassed in the Titan 1 program will permit substantially fewer Titan 2 firings.

Two Titan 2 squadrons each will be based at Davis-Monthan AFB, Ariz., McConnell AFB, Kan., and Little Rock AFB, Ark.—deployed with one missile per complex and nine complexes per squadron. Titan 2 deployment will be entirely underground. Reaction time will be less than one minute, because the propellant—half-and-half mixture of unsymmetrical dimethyl hydrazine and hydrazine, plus nitrogen tetroxide as an

←Circle Number 132 on Reader Service Card

Circle Number 133 on Reader Service Card

Raytheon brings proven guidance and sensor capability to space rendezvous

Three techniques are currently available to meet the challenge of Space Rendezvous Guidance: radar, infra-red and optics. Of these techniques, radar has been used for homing guidance systems to the greatest degree. Studies by Raytheon, whose radar experience spans three decades, have indicated that continuous wave radar possesses these desirable characteristics:

- No minimum or 'blind' ranges
- Greater range for a given weight
- Simple FM Techniques for ranging
- Direct and accurate velocity readings
- Ease of acquisition
- Greater simplicity and reliability

The experience gained from the inertial guidance system for the advanced Polaris, coupled with the proven success of the Hawk and Sparrow C W homing systems give Raytheon the most extensive proven capability applicable to the space rendezvous guidance problem.

In addition, Raytheon, one of the world's largest scientific-industrial organizations, has proven its ability to manage every phase of a complex system — from early study and design through development, production and field support of operational systems and equipment.

Missile and Space Division, Bedford, Massachusetts

RAYTHEON COMPANY

MISSILE AND SPACE DIVISION

RAYTHEON

oxidizer—is stored aboard the missile. Opening of the 490-ton sliding doors decking the silo requires a substantial part of the reaction time.

Turnover of first Titan 1 squadron (724th) to SAC at Lowry Bombing Range is scheduled for this month. Lowry will have three complexes—724A, B, and C—with three missiles each, a deployment known as a 3 x 3 configuration.

In preparation, emplacement of missiles on the elevator launchers was begun last winter. All missiles are now in place and practice elevations and loading of the propellants, liquid oxygen and RP fuel, has begun. Titan 1 deployment will be in the hardest ICBM installation thus far in U.S. operational status, in excess of 100 psi.

Simultaneous utilization of two Titan 1 launchers was demonstrated in operation Double Mirtum at Vandenberg's TF 1 training site early this year. For this operation launchers number 2 and number 3 in TF 1 were used. The exercise was, in effect, a practice run for firing in salvo. Missile in launcher number 3 was raised to the surface on its elevator and fired within approximately 7 min. The missile in launcher number 2 was put through its checkout and countdown procedure, but was not fired.

Golden Ram Payoff

Strategic Air Command operational training crews at Vandenberg beginning late last year fired five Atlas D missiles successively from gantry-type launchers. The firings incorporated refinements dictated by results of Golden Ram, an Air Force training and reliability program, and attained higher efficiency than had been achieved previously in the test program.

All model D improvements resulting from Golden Ram tests are being incorporated in the Atlas E version for semi-hardened coffin sites and F silo models, where applicable. Propellant utilization system, the same for models D and E, is being removed from both and the model F propellant utilization system will be installed in the model E. Hydrogen and helium filter systems are being installed to prevent contamination which might contribute toward mission failure, and redundant circuitry and equipment are being removed to minimize complexity. Components displaying marginal and erratic performance have been replaced. Test procedures and sequences have been updated to ensure proper checkout.

Golden Ram results are being applied sequentially to initial Atlas installations which have been turned over to SAC for operational status. A substantial number of launchers and missiles already has been updated at Warren AFB site 2 and Offut AFB, as well as at Vandenberg AFB. Remaining emplacements at

Warhead Tests Crucial for Nike Zeus

Army Nike Zeus anti-ballistic missile contractor team headed by Western Electric Co. and Douglas Aircraft Co. has slowed its design improvement program temporarily to concentrate on getting a reasonably standardized design in time for the climactic Kwajalein tests against actual re-entry vehicles this summer (AW Feb. 26, p. 64).

Subsystems now being tested piecemeal are essentially identical to those that will comprise the warhead test system. Engineers in the program believe that there is considerable performance improvement potential in the rocket and in some of the electronic subsystems, but the Army and the contractors had to select a cut-off point.

Too many variations among the missiles used in the Kwajalein tests would render the results meaningless.

Some advanced electronic components on which system performance depends have never been produced except on a pilot-plant basis. Funds for production of some long lead time items were included in early Fiscal 1963 budgeting, but were dropped from the final version.

Zeus Pacing Items

Of the subsystems, the missile itself is more susceptible to performance increases than the massive ground electronics subsystems. Because of sheer size and complexity, the Zeus radars and the target interceptor computer have been the pacing items in the development program. Substitution of a phased array type of acquisition radar for the synchronous rotating transmitter and receiver systems of the Zeus Acquisition Radar now being tested at Kwajalein and White Sands Missile Range has been considered. Aside from excessive cost and time required, some engineers in the program doubt the phased array type radar is markedly superior to the present system.

Improved propellant and weight and drag reductions are the most attainable ways to better missile performance, which could enable the Zeus to intercept incoming warheads earlier and farther from defended points.

As yet an anti-satellite mission has not become a serious goal in the Nike Zeus program.

Army officials have said that the system configuration stabilized for the Kwajalein tests can intercept low orbit satellites without modification and increased missile performance presumably would add to such capability.

Few close observers doubt that the Kwajalein tests this summer will fail to show the system to have some degree of ballistic missile intercept capability.

Production funding to a degree is likely to follow because of public fear of missile attack and widespread feeling that any defense is better than none.

No Early Decision

Top scientific advisers in the government oppose any early decision to fund Zeus production. They contend that a Zeus defense complex is susceptible to saturation and resulting penetration by real warheads and that the Zeus discrimination radars have not proven capability to identify a true warhead among a number of decoys designed to give a similar radar return. Discrimination radars, the least developed element in the Zeus system, are now being installed at White Sands Missile Range and Kwajalein for early evaluation. The Kwajalein Discrimination Radar will not be ready for the first of the 47 tests of Zeus against targets launched along ICBM trajectories from Vandenberg AFB, Calif. Some of the later tests are intended to evaluate the discrimination radar.

USAF experts are of the opinion that the proper place to destroy Russian ballistic missiles is at the launch end of the trajectory rather than at the terminal end of the missile's trajectory.

Advanced Research Projects Agency is seeking such a concept under the designation Ballistic Missile Boost Intercept System, but it is being opposed by Defense Department officials because of high cost. Receiving more serious consideration is Arpat (ARPA Terminal).

While opposing production, government scientists have reiterated for the past year that Zeus development and preproduction work should continue through the full scale evaluations of the systems.

If the ability to distinguish between penetration aids and actual warheads can be shown by that time, scientists might see fit to change their recommendation against production.

NIKE ZEUS LAUNCHING

Offut, Warren 2, and Warren 1 will be phased into the updating program quickly.

Despite the relatively short time of Atlas development considering that it was the nation's pioneer ICBM, the General Dynamics Astronautics weapon system has demonstrated its capability in military and space payload launchings. There has been a steady improvement in reliability in the systems test program—Category 1 R&D flight tests from Cape Canaveral and in complete systems testing at Vandenberg AFB, which is a combination of R&D Category 2 testing and Category 3 SAC testing. Program spokesmen declare that the Atlas system has attained a thoroughly acceptable reliability status.

The entire Atlas force—126 missiles, including 72 Fs, 27 Es, and 27 Ds, as well as 3 additional model Ds at Vandenberg AFB—is to be operational late this year.

First model F turnover to SAC is scheduled for the second quarter of this year, and the final F turnover in the last quarter. Model F deployment will involve 6 squadrons, each with 12 launchers.

Substantial Savings

Substantial savings—about $3 million to $6 million—have been made in the installation of the launchers and missiles at the three Atlas E sites, mostly through lower labor costs as a result of finishing early and expediting of components, many subsystems, at lower costs than originally anticipated. Atlas

D and E versions have, in a sense, constituted a watchdog phase for incorporating improvements into the model F system, Col John L Zoeckler, Atlas program director, reports

Skybolt Delays

Slippages continue to mark development of a U S air launched ballistic missile, the USAF/Douglas GAM 87A Skybolt First live missile launch and first complete system electrical tests, once scheduled for mid 1961, are now reported to have dropped back another three months while Congress considers accelerated funding in the fiscal 1963 budget.

Despite stop-start financing, changing objectives, oscillating manpower figures and slippages, there has been no important change in the 1964 operational readiness date originally set This is not necessarily unrealistic An advantage of the technically conservative approach applied to Skybolt is that it makes it safe for USAF to risk a higher degree of concurrency between the various phases of development and production Therefore, some testing and production may be telescoped later

The assignment of a high priority to Skybolt last summer would probably have been impossible had it not been for the cancellation of plans to develop the B 70 into an operational weapon system However, as the end of B-52 production draws near, there is no other U S aircraft in development which could be armed with the Skybolt missile

Skybolt missiles and their airborne support subsystems will be subjected to more handling than most ground-and ship-launched ballistic missile systems and this will tend to decrease reliability if no allowance is made for it Contractors are recommending that 5%-10% of production missiles be fired to ensure continuing reliability

New Projects

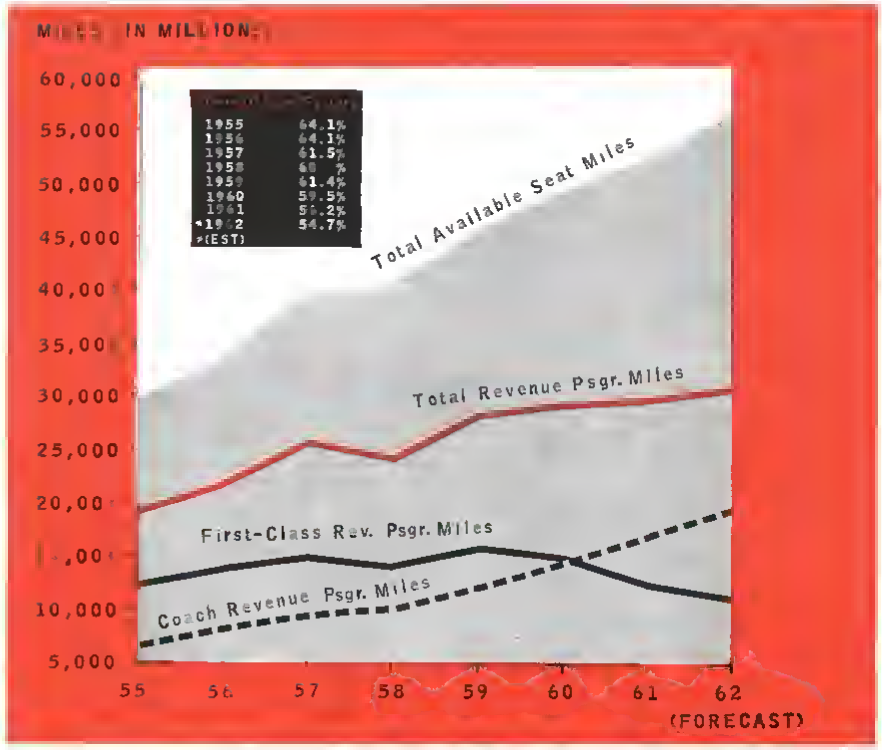
In other missile categories, Navy awarded development contracts for Shrike, a radar suppression air-to-surface missile, to Texas Instruments, and for Typhon, an anti aircraft missile, to Bendix Corp

Martin's Bullpup air-to-surface missile, now in a Navy an Air Force and a nuclear version, also reportedly will be bought by Britain's Royal Navy Sweden plans to put the USAF air-to-air Hughes Falcon on its Saab J35 interceptor

Navy which reports it has gained large price reductions in costs of the air-to air Sidewinder by bringing in General Electric as a competitive source for the guidance and control unit hopes to do the same with Bullpup by introducing Maxson Electronics Corp as a second source

AMERICAN AIRLINES' first Convair 990 jet transport

Air Transport



LOAD FACTOR IMPACT of steady switch from first class to coach travel shows creation of more coach seats and high volume of available seat miles. Over-all passenger revenue miles have remained about the same, however, causing load factor drop.

Trunk Merger Pattern Begins to Emerge

By L. L. Doty

Washington—Domestic trunkline industry, depressed by a faltering traffic market and dwindling profits, is now resigned to following the merger course as the most logical route to financial stability.

The merger fever has afflicted all but a few carriers. Enough are actively seeking merger partners to prove beyond a doubt that the industry is headed for the completely revamped route alignment predicted last year by Aviation Week and Space Technology (AW Mar. 13, p. 145).

Behind the drive for mergers is the pressing problem of overcapacity, a generic term now applied to embrace all the industry's major ills including excessive competition, sagging load factors, rising seat mile costs and falling aircraft utilization rates. Thus, only by reducing the abundance of empty seats can the industry expect to realize a healthy rate of return on investment.

So far, this appears to be an almost impossible task. Suggestions within the industry as to how it can be achieved vary widely so that no acceptable formula that might ease the problem has been developed.

Two obvious solutions are at hand: a voluntary curtailment of capacity or an expansion of air travel markets. The first solution is unpalatable to many airlines and, indeed, the swelling vortex of competition renders it impracticable.

The second solution is long-range. It calls for scientific marketing and research programs which, with rare exceptions, the industry has not yet seemed ready to undertake.

At the present time, the industry appears to be concentrating its sales efforts on travelers who already fly and who have shown no intention of deserting the airways for rails or buses.

The person who doesn't fly, for reasons of fare and fear—and no one has claimed to really know the basis for his antipathy—is seldom specifically included in airline sales drives (AW Dec. 25, p. 24). The market is there to grow, as evidenced by the fact that, in 1955, 6.7% of all U.S. adults flew on scheduled airlines, in 1961 the percentage grew to only 9.6%.

Because of this inability to raise load factors to a productive level and despite

Growth of Coach Traffic in 1961

Month	Revenue Passenger Miles (in billions)		Available Seat Miles (in billions)		Load Factor (per cent)	
	Coach	First-Class	Coach	First-Class	Coach	First Class
January	1 24	1 10	2 08	2 03	59 5	54 5
February	0 93	0 87	1 56	1 56	60 1	55 9
March	1 26	1 13	2 10	2 06	59 8	54 7
April	1 30	1 15	2 12	2 05	61 3	56 2
May	1 28	1 09	2 28	2 05	59 9	53 3
June	1 63	1 18	2 47	2 10	65 7	55 8
July	1 67	0 99	2 63	2 14	63 7	46 1
August	1 75	1 03	2 71	2 13	64 8	48 2
September	1 56	0 97	2 59	2 01	60 1	48 6
October	2 47	1 04	2 63	2 09	55 8	50 8
November	1 38	0 97	2 57	2 00	53 8	48 6
December	1 59	0 93	2 62	1 88	60 8	49 1

Domestic Trunkline Traffic Activity During 1961 Compared with 1960

Month	Revenue Passenger Miles (in billions)		Available Seat Miles (in billions)		Load Factor (per cent)	
	1960	1961	1960	1961	1960	1961
January	2 41	2 34	4 04	4 11	59 5	56 89
February	2 12	1 81	3 79	3 12	56 4	57 92
March	2 27	2 39	4 07	4 17	55 7	57 26
April	2 49	2 45	4 07	4 17	61 2	58 70
May	2 43	2 37	4 12	4 33	59 8	54 66
June	2 70	2 81	4 05	4 60	66 7	61 14
July	2 69	2 66	4 33	4 77	62 1	55 79
August	2 72	2 78	4 40	4 84	61 9	57 45
September	2 53	2 53	4 11	4 60	61 6	56 00
October	2 48	2 53	4 19	4 73	59 1	53 60
November	2 12	2 36	3 90	4 57	54 3	51 50
December	2 27	2 52	4 08	4 50	55 7	55 92

Comparison of Various Revenue Passenger-Mile Forecasts (in billions)

Date Published	CAB				FAA		Convair		Carriers
	Total Domestic		Domestic Trunk		Total Domestic		Total Domestic	Domestic Trunk	Domestic Trunk
	December, 1959				Dec 1956	Aug 1959	July 1958	July 1958	Oct 1957
	actual		actual						
1958	25 3		24 4						
1959	29 1	28 5	28 1	27 5	31 8	28 5	30 0	29 0	31 0
1960	30 3	32 0	29 2	30 9	35 0	31 4	33 7	32 5	35 2
1961	30 9	35 7	29 5	34 4	37 8	34 1	38 0	36 6	39 7
1962		39 6		38 2	41 1	36 8	42 2	40 6	42 7
1963		43 9		42 3		39 5	45 7	43 9	
1964		48 3		46 5		42 2	49 5	47 4	
1965		53 0		51 0	49 0	44 9	53 0	50 7	

Source: CAB, Office of Carrier Accounts and Statistics, Research and Statistics Division Staff Research Report No. 1—Forecast of Airline Passenger Traffic in the United States: 1959-1965

optimistic forecasts predicting a 6-10% increase in traffic this year over 1961, prospects for any substantial improvement in net earnings this year are slim. There is some indication that spiraling cost may level off—for one, Northwest Airlines has been markedly successful in holding expenses down. But, generally, the industry seems to have surrendered to the grim fact that annual cost increases are all but inevitable.

Overcapacity is one of the prices the industry is paying for its hasty conversion from piston to turbine aircraft.

This should not imply that the airlines rashly purchased more equipment than they could economically use. Considering the importance of maintaining a relatively high aircraft utilization rate, trunklines have shown remarkable restraint in the production of seat miles. The 6.8% increase in available seat miles registered in 1961 is completely overshadowed by the 14.22% annual increases reported in pre-jet years.

A number of other factors contributed to the overcapacity problem and many of these were beyond the control of the airlines. They include:

- **Traffic forecasts**, conducted as early as 1956, were used as guidelines in the planning of jet fleets but all of these projections have proved grossly inaccurate (see chart). Forecasts prepared by CAB, Federal Aviation Agency and Convair predicted that revenue passenger miles generated by all domestic carriers—including local service airlines—would reach totals ranging from 34 billion to 39 billion. Actual volume last year was 31 billion. But the most glaring error in projection was committed by the industry itself. In 1957, during the general passenger fare investigation, trunklines estimated revenue passenger miles would climb to 39.7 billion in 1961. Actual total was 29.5 billion.
- **Traffic volume** in the past two years has failed to match even the subnormal increase in available seat miles. Compared with the 15.1% rise in revenue passenger miles in 1959, traffic was stagnant, moving up only 3.9% in 1960, 1% last year. During 1961, traffic actually showed a decline in five months of the year. It showed substantial increases only in November and December. Forecasters are now looking for a 6% average rate of increase during the 1961-66 period but they base their predictions on a projected average rate of 3.5% growth in general business activity.
- **Inability to dispose** of piston-engine aircraft has forced a number of airlines to press back into service aircraft which they had expected to sell under re-equipment programs. This has helped to increase seat miles. Some airlines—particularly Delta and Eastern—have offset this increase by operating fully depreciated piston aircraft under service conditions or in areas that would prove uneconomical for turbojet or turboprop aircraft.
- **Additional route mileage** created by route awards of the CAB since 1955 has obviously accelerated seat mile volume. Necessity for new carriers awarded such routes to keep abreast of firmly rooted competitors by matching schedule for schedule also generated new seat miles.

In almost each case, these causes of overcapacity could have been alleviated if adequate research and study had been undertaken in the middle-1950s. Most traffic projections, for example, were based on assumptions that had little or no scientific support.

Subjective Analyses

One study, a CAB forecast, stated that judgment of the investigators was involved in "developing the appropriate assumptions as to the changes that may be expected to take place in the underlying factors during the forecast period." Projections made in most forecasts were based on past experience and the historical relationship of airline traffic to such factors as population growth, per capita income, consumer price levels, gross national product and surface transportation.

Some forecasts accurately predicted the large role coach travel would play in the total traffic structure. And when orders for jets were first placed, many industry officials were ominously aware that disposal of piston-engine aircraft would pose a severe problem. Few, however, believed that the used-plane market would be so selective that some aircraft would be scrapped, like the Lockheed 049 Constellations inherited by United from its merger partner, Capital.

The industry and the CAB blame each other for the rash of route awards made after 1955 when the CAB established its policy of strengthening regional carriers by placing them in competition with Big Four carriers in high density markets. With six major routes now served by six airlines, two routes served by seven carriers, three by eight and one by nine, excessive competition and encompassing overcapacity have prevailed.

The industry charges that Board generosity thus created today's financial dilemma. The Board staff counters that the airlines fought for the routes offered without restraint and now are caught with exactly what they asked for. Airlines retort that they were forced to fight for any routes offered in route cases in their own interests to keep competition from gaining too firm a stronghold in any given market.

The severity of the problem is underscored by the fact that, for 1961, only 7 of the 11 trunklines are expected to show a profit. American's profit dropped from $11.7 million in 1960 to $6.8 million last year. United's net earnings fell from $11 million in 1960 to $3.7 million in 1961, the dip being attributable in large part to the cost of integrating the Capital system into its operation.

Braniff showed an increase in net earnings and so did Delta and National.

TWA CONVAIR 880 AT NEW LOS ANGELES INTERNATIONAL AIRPORT TERMINAL

Domestic Intercity Passenger Miles

(For Selected Years, In Millions)

	1939	1949	1959	1961(Est.)
Railroad Travel:				
First Class	7,527	9,349	3,798	3,129
Coach	11,180	20,273	13,704	12,728
Total	18,707	29,622	17,502	15 857
Air Travel:				
First Class	654	6,454	16,847	17,095
Coach		251	12,304	13,756
Total	654	6,705	29,151	30 851
Motor Bus Travel	9,100	22,411	14,400	20,000
Total Common Carriers	28,461	58,738	61,053	66,708
Airline Share of Total (%)	2 3	11 4	47 7	46 2
Railroad Share of Total (%)	65 7	50 4	28 7	23 8
Bus Share of Total (%)	32 0	38 2	23 6	30 0
Private Automobile Intercity	234 700	376,313	659,435	685,000
Total Common Carrier and Auto	263, 161	435,051	720,488	751,708
Airline % of Total Intercity Travel	0 2	1 5	4 0	4 1
Railroad % of Total Intercity Travel	7 1	6 8	2 4	2 1
Bus % of Total Intercity Travel	3 5	5 2	2 0	2 7
Auto % of Total Intercity Travel	89 2	86 5	91 6	91 1

Comparative Direct Operating Costs—Domestic Trunklines

(Cents per plane-mile 12 months ended Sept. 30,1961)

	Flying Operations	Direct Maintenance	Applied Maintenance Burden	Depreciation	Interchange Expense	Total Direct Operating Expense
DC-3	52 77	17 10	12 10	3 31		84 48
CV-240	59 23	28 16	34 83	6 59		128 69
CV-340	53 52	20 63	14 95	6 05	1 67	96 65
M-404	56 01	18 93	10 87	3 38		87 18
DC-4	71 22	28 66	21 96	1 24		128 04
DC-6	73 99	28 07	27 47	1 63	4 36	135 33
DC 6A	75 79	25 19	26 20	36 97		163 72
DC-6B	79 07	27 58	22 15	26 50	3 49	159 14
DC 7	77 04	32 77	25 23	56 56	8 54	200 65
DC-7B	77 48	29 99	17 02	41 98		167 25
DC-7C	86 88	40 37	18 62	35 46		185 88
L-049	81 12	27 25	27 93	0 47		137 20
L-749	85 32	30 18	30 83	3 08		149 64
L-1649	76 46	42 36	20 67	3 92		140 53
L-1049C	77 63	31 89	13 98	6 04		129 27
L-1049G	93 15	40 83	31 38	61 01		230 54
L-1049H	109 59	32 33	30 94	76 70		252 06
L-1649	88 51	43 33	35 37	110 61		279 20
C-46	45 90	24 73	18 61	14 18		103 42
Viscount	53 66	23 61	17 95	18 34		113 84
Electra	76 64	43 08	16 01	43 36		179 82
B-707 & 720	95 01	31 72	24 88	27 55	1 13	180 71
DC-8	91 44	32 19	21 19	39 21	5 68	191 26
CV-880	98 90	42 45	21 92	30 56		194 55

Airlines, both of which began new southern transcontinental services last year. Continental Air Lines reported a net profit for 1961, slightly under that registered in 1960.

Some carriers, led by United, seek a further fare increase as a means of fattening revenues to help widen the profit margin. Others, headed by Continental and Trans World Airlines, think lower fares will attract new business.

Failure of the TWA-sponsored transcontinental excursion fare and the American-backed Youth Fare Plan to win industry support last year was a set-back to the low fare advocates. Because it was not fully possible to prove that the low fares spawned new traffic or opened new markets, members of the high fare bloc lost no ground in the hassle.

Meanwhile, Continental is not tempering its drive for an excursion fare and United vigorously continues to wage its campaign for a 3.5% increase in addition to the 3% hike the CAB granted recently across-the-board. The battle lines are simple: one group insists that, if traffic remains at a standstill, then revenues must be boosted by high fares. Another group holds that higher fares will deter some travelers from using the airlines but that lower fares will lure new travelers from the highways, particularly on long-haul routes.

Policy Discord

A few stand in the middle. They feel that this is not the time to make an adjustment in tariffs. Consequently, the discord within the industry on policy matters, contrasted with the harmony that ordinarily exists in technical areas, can be expected to keep many airline presidents in their worn but familiar hangers. Besides preventing the formulation of standards, this threatens to bar the way to many a logical merger.

The new CAB chairman and vice chairman, Alan S. Boyd and Robert T. Murphy, respectively, together with former chairman, Whitney Gillilland, and veterans Chan Gurney and C. Joseph Minetti constitute the new Board. It will probably remain this way for at least three years since the first term to expire is Gurney's in 1964.

Boyd has assumed full leadership of the Board and has detailed his stand on major issues in a series of articulate and thought-provoking public addresses. There are signs that he feels he has now fully expressed his views and will redirect the number of his speeches substantially.

If there is any criticism of Boyd it is that he has failed to take any action on the measures he has proposed publicly. The fact of the matter is that Boyd firmly believes it is the full responsibility of management to take those steps necessary to attain economic stability. The Board, he believes, can only guide and approve or disapprove in the public interest.

If Boyd has taken no direct action, his speeches at least have prompted industry response. The airlines are now moving and moving in new, if not revolutionary, directions. He has them talking merger. One merger has been completed. Two—the Eastern-American and the now defunct Continental-National mergers—have been proposed. Others are hatching.

His call for new devices for generating traffic has evoked a number of promotional fare innovations. New ideas, innovations and plans are streaming into the Board with fresh assurance of a warm reception.

At the present time, the CAB has no major route cases to cope with although, of the 1,316 cases pending as of last June, 586 are concerned with domestic routes. In addition, route adjustments and consolidation of routes required by proposed mergers will throw a heavy workload on the CAB.

The Board has indicated that it will place new emphasis on adequate service standards, siting of airports and co-ordination of air and surface transportation as route adjustments occur which stem from the transfer of short-haul routes to local service carriers and from concentration on long-haul routes. United has asked for a moratorium on all route awards until the overcapacity problem is corrected.

Major route case last year was the Southern Transcontinental Service Case in which National was awarded a Florida-California route, Delta a Georgia-California route and Eastern a Miami-Fort Worth route. Pending and set down for hearing is Northeast Airlines' bid for a permanent certificate on its New York-Florida route. Issues in the case have been broadened to determine whether, if the route is renewed, Northeast should be merged with another carrier.

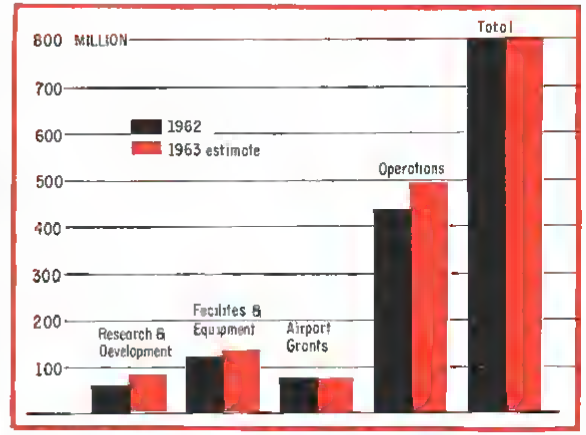
Last year, Boyd initiated several reorganizational changes in moves to meet the towering workload facing the Board. Budgetary limitations prevent any significant personnel expansion. Office of the executive director was given more authority and the position of assistant executive director and secretary was created to assist in the direction of the Board's work.

A planning office and an office of community and congressional relations were established. Organization of the economics staff was realigned with the creation of a new Bureau of Economic Regulation comprised of three divisions: routes and agreements, rates, and subsidy.

The Board has proposed legislation that will prevent domestic trunk airlines from seeking subsidy when conditions are such that inadequate earnings are shown. The Board also wants legislation that will authorize it to regulate depreciation accounting.

The Board's Bureau of Safety, headed by Melvin N. Gough, handled 660 accident investigations and 97 incident investigations during the 12 months ended June 30, 1961. A total of 30 formal accident investigation reports were issued.

The industry's 1961 safety record, with only three accidents involving passenger fatalities, was outstanding, a tribute to carriers' successes in introducing the turbojet transport into service. On time performance records continue to improve and passenger appeal of the high speed aircraft stays at a top level.



FEDERAL AVIATION AGENCY budget comparison shows projected Fiscal 1963 spending. Not all categories are listed, and columns do not add up to the total at right.

Pooling Expected

Pooling of such activities as maintenance, overhaul, distribution of spare parts and engines, catering and ground facilities can be expected to spread during the next year as a result of the industry's drive to curtail costs. It is also possible that the passenger may find some of the familiar frills and give-aways taken from him in the push for economy.

Most action now is based on full recognition that the trunklines have matured into big business, that financial stability must be established at all costs. Mergers are looked upon as the key to cutting down seat mile costs, overhead and operating expenses—the first step toward profits.

Loss of identity and jockeying for position by key officials or unhappy stockholders are the chief blocks to mergers. The Board is not likely to disapprove most mergers unless they are found not to be in the public interest. As long as competition is retained, the Justice Department will probably do no more than determine that no monopolistic element exists.

The question is often asked as to why Eastern was willing to submerge its identity through a merger with American when its fiscal position and its financing programs are apparently sound.

In response to this, Malcolm MacIntyre, Eastern's president, asserts that Eastern is not being submerged, that the influence of its character will be felt within the merged company.

He adds that the sound financial condition is meaningless as long as a low rate of return is present. Through the merger with American, he says expenses can be consolidated and seat mile costs can be cut sufficiently to provide the needed rate of return.

1961 was a crucial year for the industry in that depressed earnings and poor traffic showings emphasized the need for some revamping of the route structure to eliminate unnecessary competition. 1962 is very likely to be the year that the future makeup of the industry will emerge into sharper focus.

If the anticipated traffic increase does materialize, it probably will fail to lull the airlines back into lethargy since the effects of 1960-61 airline depression will not be easy to remove. As noted last March (AW Mar. 13, p. 150), "some basic change in the industry now appears inevitable." It would seem now safe to say that those basic changes are in the making.

TRANS CARIBBEAN AIRWAYS TURBOFAN DOUGLAS DC-8

U.S.-Foreign Airline Competition Grows

By Glenn Garrison

Further intensification is in prospect this year in the competitive battle between U. S. flag carriers and foreign competitors for traffic which, instead of growing to match the vastly increased seat capacities, has shown a tendency to level off in some important areas.

Major controversies between the U. S. and other governments over bilaterals and interpretation of agreements have been heightened by the pinch of falling load factors. These arguments are likely to multiply in 1962 and to affect U. S. policy in international aviation.

Disagreements within the International Air Transport Assn. led last year to demands for changes in that organization's structure and mounting criticism of the association itself. Important issues in the inter-IATA struggle have been rates and the control of the executive committee.

U. S. carriers' share of the 4,954,311 passengers who traveled between the U. S. and foreign countries during the year ended June 30, 1961, was 49%, or 2,458,313 passengers. This represented a drop from 55% for U. S. carriers in the year ended June 30, 1960. Overall total was an 8% increase over the 1960 total, compared with a 13% increase the previous year.

Particularly hard hit by the overcapacity problem was traffic on the North Atlantic, which increased only 9% in 1961 despite an available seat increase of 37%.

Largely because of this North Atlantic situation, Trans World Airlines showed a drop in traffic last year over its international routes. Passenger total fell 18% to 284,278 passengers while capacity increased about 4% to 1,977,916,000 available seat miles. In 1960, TWA's international traffic rose 42%, while capacity was up 57% over 1959. In 1961, TWA's international routes accounted for 18% of the system total of revenue passenger miles and 19.4% of the system revenues.

Optimism Expressed

TWA however, says it is encouraged by a pickup during the last part of 1961 and early 1962. Expecting a better North Atlantic season this year, it will increase its transatlantic peak weekly capacity from 40 to 46 jet round trips, including four from the West Coast. During 1961, TWA—which is now all jet on its international routes—extended jet service to Zurich, Geneva, Tel Aviv, Cairo and Shannon. It revised its route pattern by temporarily suspending service at Bangkok and Colombo, as well as Tunis and Shannon, although it expects to return to Shannon this year. The airline will offer a total of 522,900 seats each way this year in transatlantic service—an increase of 25.7%.

Pan American showed gains for 1961 in every area except the Alaska service. In the Atlantic service which includes inter-European traffic, passengers increased from 1,569,000 to 1,767,000, revenue passenger miles rose from 2,069,000,000 to 2,527,000,000, but load factor dropped from 62.4% to 53.1%. Available seat miles rose from 3,314,000,000 to 4,759,000,000. In the Pacific service, passenger total climbed from 542,000 to 612,000, available seat miles rose from 2,263,000,000 to 2,942,000,000, and passenger load factor was up from 59.2% to 66.8%. In Pan Am's Latin American Division, passenger total was up from 1,301,000 to 1,353,000, available seat miles were up from 2,152,000,000 to 2,589,000,00, but passenger load factor dropped from 66% to 63.1%. In Alaska service, passenger total fell from 69,000 to 63,000 and passenger load factor was down from 52.7% to 43.8%. System passenger total for 1961 was 3,795,000, up from 3,481,000. System passenger load factor was down from 65.2% to 59.3%. Available seat miles on Pan Am's system rose from 7,864,000,000 to 10,438,000,000.

Pan Am began jet service to a number of points including Scandinavia, Brazil, Costa Rica, Mexico City, islands in the Antilles, and Panama in 1961. Last month, the airline inaugurated nonstop jet service between New York and Jamaica after Civil Aeronautics Board route award.

On the North Atlantic, Pan Am plans a heavy capacity for the peak season, with 184 flights a week in both directions, up from 152 flights during the last peak season. This will provide about 200,000 seats a week in each direction a total Pan Am says is more than twice the total of jet flights offered by any other carrier. Pan Am will be operating five new 707-320B long-range turbofan jets in the service by next summer.

Panagra, increasing jet frequencies on its South American routes, boosted revenue passenger miles in 1961 to a total of 229,500,000. Cargo ton miles increased 19%. New economy fares, instituted on routes last May, were credited with stimulating traffic. The new rates brought the New York-Buenos Aires jet round-trip fare down from $934 to $599, with comparable reductions at other points. Panagra increased DC-8 service to Buenos Aires from four to six flights a week and inaugurated five-times-weekly jet service to Santiago. Pattern of jet service was extended to other points.

Increased package tour sales to South America was experienced by Panagra in 1961, and also northbound all-expense tours to visit this country were introduced in Argentina, Bolivia, Chile, Colombia, Ecuador and Peru. Panagra instituted a number of promotional efforts to increase tourism between the U. S. and South America.

Pacific Market

Reflecting the growth of Pacific travel, Northwest Airlines in 1961 showed an increase in revenue passenger miles from 317,328,094 to 341,518,921. Available seat miles on the carrier's international routes, which include Alaska and Hawaii flights, increased from 664,032,843 to 706,252,973.

During 1961, Northwest boosted its transpacific jet services to daily frequencies in both directions. It increased its polar Imperial service from New York to Tokyo via Alaska to three weekly, one of which provides direct service from Chicago to Tokyo by stopping at Chicago. During the year, five Douglas DC-7C piston aircraft were modified to all-cargo configuration and all-cargo service now includes a weekly round trip from New York to Tokyo via Chicago, Seattle-Tacoma and Anchorage. Other DC-7CF cargo aircraft, with passenger accommodations fit between Seattle-Tacoma and Anchorage.

For 1962, Northwest's sales objectives include an increase in international traffic of about 20%.

In the Mexican market, gains were shown by Eastern Air Lines while American registered a drop in business. Eastern's 1961 total of passengers in and out of Mexico City was 82,764, up from 49,247 in 1960. Passenger miles increased from 75,312,000 to 140,646,000 and load factor went up from 51.6% to 64.6%. Eastern enjoyed an advantage in its New York-Mexico City nonstop market where its chief competitor, Aeronaves de Mexico, lacked jets to compete with Eastern's DC-8s.

American's passengers in and out of Mexico City, which it serves from Chicago nonstop and from Dallas, dropped from 111,000 in 1960 to 85,600 in 1961. Passenger miles dropped from 114,159,000 to 92,586,000, and load factor was down from 59% to 53%. American replaced DC-7 piston equipment on the Chicago-Mexico route last March with turbofan jet equipment, and later in the year phased the 707-120Bs and 720Bs into Dallas-Mexico service.

Eastern's other international routes showed a decline in 1961 from 1960. At Bermuda, passengers totaled 40,618 last year, down from 43,808 in 1960. Load factor however, picked up from 51.6% to 64.6%. During 1961, tourist service was inaugurated to Bermuda from Newark, Philadelphia and Washington.

At Puerto Rico, Eastern's passengers declined in 1961 from 398,756 to 383,545, and load factor dropped from 70.1% to 66.2%. A 1961 development in this market was inauguration of several air bus services to San Juan.

Trans Caribbean Airways last year received further exemption to operate into Aruba and has increased its service, flying DC-6Bs between San Juan and Aruba at a $50 round-trip fare. Trans Caribbean's growth as a competitor in the New York-Puerto Rico market was decelerated during 1961 by a lack of jet equipment, but the airline last fall put a turbofan DC-8 into the service and has ordered another. It expects a big year in 1962. It was an unsuccessful applicant for New York-Jamaica nonstop service.

Delta Air Lines experienced another unfavorable year in the Caribbean, attributing the results to political unrest. Its stop at Havana, Cuba, was finally discontinued last December. Total of international passengers in 1961 was 17,578, down from 27,578 in 1960. Available seat miles dropped 35.9% to 58,138,000. Delta serves Caribbean points, including Caracas, Port au Prince and San Juan with DC-7 equipment, last December began Convair 880 jet service on a weekly basis to Jamaica and Caracas through the New Orleans gateway. This flight originates in San Francisco. Delta expects to promote the Caribbean extensively as a travel attraction for Californians. Last year the international operation accounted for only 2% of Delta's system operations.

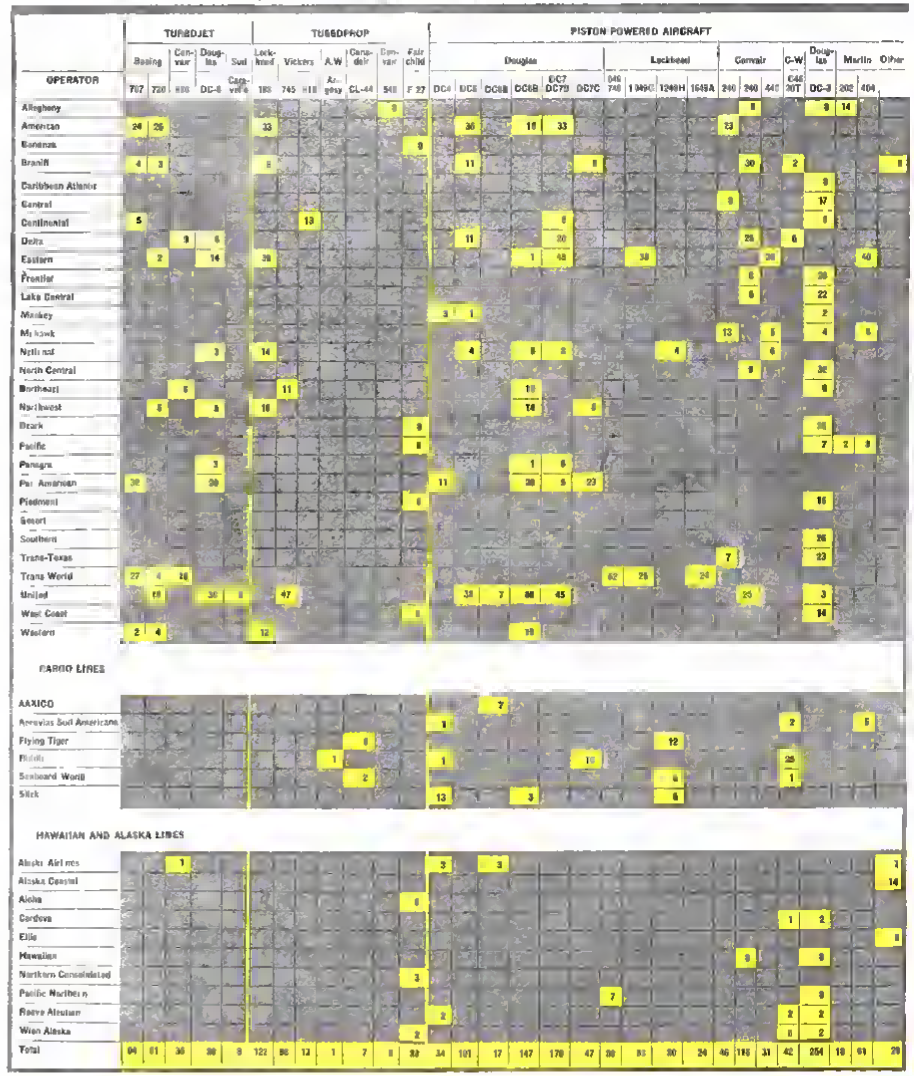
Braniff Airways showed a marked increase in international traffic in 1961, with passenger total rising at 47.6% to 96,416 passengers. Available seat miles increased 18.8% to 287,328,000, and revenue passenger miles increased 10.6% to 142,108,000.

Braniff attributes much of the gain to its Mexico City route, operated for a full year for the first time in 1961. The airline expresses optimism over the potential of its international routes, citing increasing tourist travel to South America and economic expansion of the Latin American countries it serves. A new middle-class market is developing in these areas, Braniff says. To develop these markets, Braniff's plans include addition of international sales experts in major U. S. cities.

NORTHWEST AIRLINES BOEING 720B

Aircraft Engaged in U. S. Air Transportation

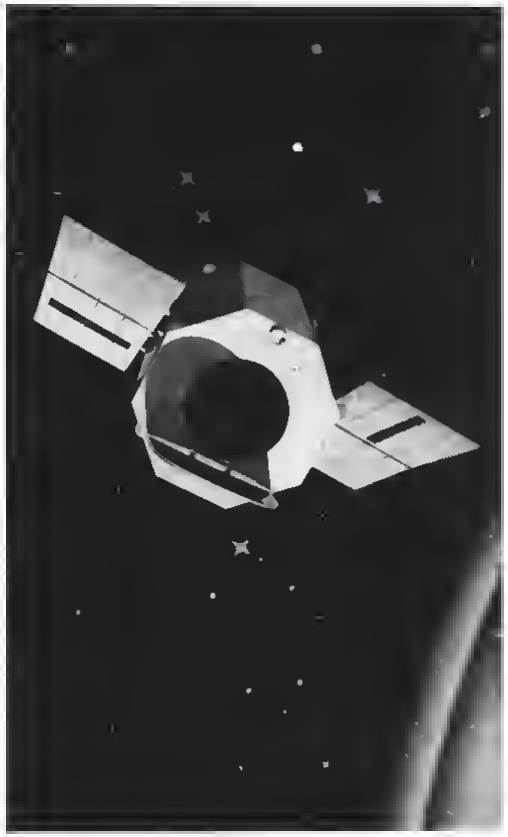
SCHEDULED AIR CARRIERS, DOMESTIC AND INTERNATIONAL AS OF SEPT 30, 1961



WHAT GRUMMAN CAN DO.....AND DID

SPACE CAPABILITY—Grumman activities in the space field are highlighted by the OAO—one of the largest satellites contracted for by the National Aeronautics and Space Administration to investigate the mysteries of space hitherto unknown to man. Other activities are in capsule retrieval, lunar vehicle control, atmospheric reentry, hypersonics, space tracking, and many more.

HYOROFOIL CAPABILITY—Grumman is the world's leader in high-speed hydrofoil technology. A 117-foot, 90-ton craft, the H S Denison is nearing water trials and will be the world's first open ocean hydrofoil. An even newer 300-ton hydrofoil research ship is also under development as the potential forerunner of a whole new class of naval escorts.



PRODUCTION OF THE NAVY'S A2F-1 INTRUDER—an airborne weapons system designed to deliver weapons on target under the screen of radar regardless of weather or darkness. The A2F-1 can fly long distances with nuclear capability or provide close ground support in a brushfire war.

PRODUCTION OF THE W2F-1 HAWKEYE—the Navy's newest airborne combat intelligence center. The Hawkeye provides Navy task forces with the ability to detect and evaluate enemy forces well in advance of time needed for successful interception. The W2F-1 is a good example of Grumman's ability to administer complete complex systems from initial design to final utilization.

PRODUCTION OF THE S2F-3 TRACKER, newest version of the Navy's standard carrier-based antisubmarine aircraft. Using radar, sonobuoys and magnetic detection equipment, the S2F-3 detects, identifies, tracks and destroys enemy submarines.

PRODUCTION OF THE ARMY'S AO-1 MOHAWK—the first propjet-powered aircraft to enter Army service. The Mohawk is designed to "live" in the field with tactical troops and provide all-weather day and night observation. It's designed to operate from short runways, unimproved fields or from cow pastures 600 feet long.

PRODUCTION OF THE GRUMMAN GULFSTREAM—the most useful and usable business aircraft in the world. The Gulfstream takes off from runways as short as 3,500 feet, flies (pressurized) at 30,000 feet, cruises at 350 mph. Over 80 Gulfstreams are now in operation, setting outstanding utilization records and proving their safety, reliability and low operating costs.

Grumman

GRUMMAN IS ALSO ACTIVELY ENGAGED IN: electronic systems integration, missile design and development, power and sailboats under the famous Pearson name, and the production of two airplanes not shown above: the Ag-Cat, an agricultural sprayer-duster, and the SA-16 Albatross, an air-sea rescue amphibian in service all over the world.

GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

Bethpage · Long Island · New York

U. S. Local Service Airlines

SELECTED OPERATING STATISTICS—1961

	Rev Plane Miles (000)	Rev Passenger Miles (000)	Passengers		Average Passenger Load	Passenger Load Factor (%)	Total Rev Ton Miles (000)	Ton Mile Util (%)	Ave. Rev Load (Tons)	Performance Factor (%)	Revenue Hours	Off-On Speed	No of Departures	Ave Length of Hop (Miles)	Daily Aircraft Utilization
			Originating	Enplaned											
Allegheny	9,799	172 562	027 274	835,291	17 6	42 9	18 126	46 4	1 85	93 5	56 516	173 4	89 664	189 3	4:40
Bonanza	4 397	79 888	316 559	320,328	18 2	47 8	7 961	48 9	1 81	99 2	28,956	209 9	34,676	126 8	6:34
Central	5,743	47 739	243,847	253,214	8 3	35 3	5 125	33 8	0 89	97 3	38,358	149 7	68 485	84 8	5:56
Frontier	9 437	97 982	358 138	404 219	10 4	38 4	10 699	41 7	1 12	97 7	57,482	163 6	98,998	101 7	5:17
Lake Central	6.658	64,204	299 077	407 413	9 6	24 8	6 725	36 2	1 01	96 5	46 843	142 1	87 505	76 1	5:12
Mohawk	8.582	162 149	789 804	843,498	19 1	44 5	16 533	42 8	1 94	94 2	49 536	171 6	80 341	105 8	5:28
North Central	15 211	187,822	1 010,508	1,095 859	12 3	43 0	19 999	44 6	1 31	98 4	100,156	151 9	186,907	81 4	6:49
Ozark	8.789	102,807	569,431	577,168	11 7	43 1	10,887	48 2	1 24	98 1	58,698	149 8	99 637	88 2	6:08
Pacific	5.297	104,907	448 078	456 047	19 8	48 5	10,380	45 9	1 96	98 1	29 270	181 8	51 097	183 7	3:31
Piedmont	7.804	185 941	498 913	545 029	13 6	45 9	10 844	47 6	1 39	97 2	49,262	158 6	91 347	85 4	5:34
Southern	8,213	71,280	392,276	401,711	8 7	33 1	7,804	35 8	0 93	96 7	58,912	152 3	96 614	85 8	5:33
Trans Texas	7,725	74,896	321,657	330,720	9 7	37 1	8,077	38 3	1 05	96 9	47,889	161 2	79,014	97 8	4:32
West Coast	6,774	93,591	379 171	459 281	13 8	43 1	9,469	43 6	1 40	97 9	62 028	161 2	73 347	92 6	5:45
Total Average	104,349	1 265,789	6,554 433	6,930,467	13 1	41 8	142,428	42 2	1 26	96 9	651 000	160 3	1 129 552	92 4	5:24

Source: Ray and Ray

Locals Gain Under Class Rate Formula

By Robert H. Cook

United behind their initial success with the new class mail rate formula, local service airlines are preparing a strong defense of subsidy expenses this year to avert any reduction which might detract from new route awards and aircraft re-equipment programs.

Adoption of the new subsidy formula, most local carriers feel, has given them their first practical opportunity to expand at a minimum of government cost while providing a maximum of benefit to the public

Last year the airlines enjoyed record operating profits under the formula and cut nearly $2 million from the local service industry subsidy bill predicted by the Civil Aeronautics Board. At the same time, breakeven need of the airlines, which had increased about 25% a year for the two previous years, increased only 2%, despite the addition of nearly 3,000 new route miles.

Spur to Growth

From the standpoint of future growth possibilities, the locals consider the class mail rate as an invaluable spur to greater investor interest. For the first time in its history the industry last year turned from its customary net loss position to earn an average rate of return on investment of 9%. The airlines' equity position long stagnant because of the poor earnings record, nearly doubled in the period.

However, there is strong concern within the industry that congressional zeal to trim the subsidy bill further—a bill expected by CAB to peak at $86 million in Fiscal 1963—might result in irreparable damage to the class rate system before it can be refined to a point of maximum efficiency.

While the CAB's budget request to Congress increases payments to the 13 local service carriers an estimated $4 million, to a $71.4 million total, payments for helicopter and Alaskan carrier operations have been reduced a total of $1.4 million. Any further subsidy cuts would be likely to come from payments to local service carriers, forcing a change in service and re-equipment plans for many airlines and possible changes in the class mail rate formula.

Third-Level Carriers

Further complicating and confusing the subsidy issue is CAB's consideration of a new class of third-level carrier to provide service to communities unable to support local service under the Board's use-it-or-lose-it policy.

On one hand CAB has given clear notice that it is concentrating on helping the locals to drop unproductive points as a means of reducing their subsidy needs, the carriers point out. On the other, such influential senators as Warren Magnuson (D-Wash.), chairman of the Senate commerce committee, and A. S. Mike Monroney (D-Okla.), chairman of the Senate aviation subcommittee, have taken strong stands supporting the new class of carriers, even though this could result in a heavy demand for more subsidy.

CAB Approval

CAB approval of these applications, opponents claim, would not only amount to a complete reversal of the Board's philosophy and desire to reduce subsidy, but would also place CAB in the same position it was in more than a decade ago when the struggling local service industry claimed it needed larger and faster aircraft, along with longer routes and heavy population centers, in order to make a profit. Advocates of the third-level carrier visualize their using light twin aircraft more suited in capacity to the traffic they would carry and thus less costly to operate and requiring less subsidy.

Having taken the stand that it has already progressed towards reducing subsidy by implementation of the class mail rate, and reductions for Alaskan and helicopter operators, the CAB, along with the local service airlines, faces yet another immediate challenge from Congress.

Chairman Albert Thomas (D-Texas) of the House Independent Offices Appropriations Subcommittee recently held a closed door session on subsidy with four local service airlines selected on a geographical basis: Allegheny, Southern, West Coast and North Central. With the exception of Allegheny, all of these airlines earned profits high enough to share in the profit sharing provision of the class mail rate. They were asked to appear with sufficient financial proof to support their subsidy claims.

Profit sharing could be one of the changes under consideration by CAB. As it now applies, the provision calls for a rebate by the airlines to CAB of any profits earned above their established rates of return, which range from 9 12.75%. Between this level and 15%, the rebate is 50%. Above 15%, a rebate of 75% is required.

Rate Studies

Both the CAB and the airlines, through the Assn. of Local Transport Airlines, have studies under way on possible revisions of the class mail rate system. The Board hopes by July to compare studies with ALTA which has employed the firm of Systems Analysis and Research Corp. of Washington, to conduct its study. CAB has found that the formula fails to reflect the changing conditions imposed by the addition of new route miles and equipment. This has necessitated the Board's making a series of individual adjustments to the monthly subsidy applications of the carriers.

In a recent conference with the Board, ALTA placed the blame for the industry's low load factors and high subsidy on the large percentage of unproductive points served by the carriers. As of Sept. 30, 1961, the Association reported, 127 points served by the local service operators generated less than five passengers a day. Terming this figure critical because these points represent 25% of the present local service system, ALTA requested the removal of unproductive points and their replacement by more profitable routes.

While the industry has gained impressive route mileage in the past years, ALTA said, the points which CAB dropped have been far outnumbered by the high percentage of equally unproductive points generated in the route awards.

As an example, the organization said CAB in 1959 deleted 11 stations which were generating less than two passengers a day, but in the same year added 30 new stations which also generated less than two passengers a day. From

Local Service Airlines

Earnings History (Thousands of Dollars)

	Total Operating Revenues (Includes mail pay)	Total Operating Expense	Net Operating Income	Net Profit (or Loss) After Taxes and Interest
1950	27 683	27,088	595	(566)
1951	36 726	35,964	762	147
1952	42 379	43,497	(1,118)	(487)
1953	49 358	50,903	(1,545)	(2,033)
1954	55,847	54,239	1,608	955
1955	58 566	57,842	724	394
1956	67,711	68,294	(583)	(800)
1957	82,139	82,900	(760)	(1,153)
1958	94 953	93,336	1,616	1,137
1959	122,822	122,185	636	62
1960	146 481	144,309	2,172	1,939

Source: Gay and Gay

Preliminary or Estimated Financial 1961 Results

	OPERATING REVENUES				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non-mail	Mail and Subsidy	Total		
Allegheny	5,656 319	5,875 276	3 271 978	9 247 254	8,096 359	1,150 895
Bonanza	3,695 378	4 038 490	4 031 491	8 069 981	7 864 088	205 893
Central						
Frontier						
Lake Central	5,367 829	5 756 074	4 077 019	9,813,093	9,536 328	276,765
Mohawk	12 758 311	14 283 599	4 485 339	18 767 938	17 984 278	783 660
North Central						
Ozark	8 075 188	8 777 829	4 486 174	13,264 003	12,528 264	735 739
Pacific	6 389 439	6 988 636	4 106 545	11,095 301	10,139,599	955,602
Piedmont						
Southern						
Trans-Texas	5,375 366	5,960,305	4 179 689	10,039 994	9,854,853	185,141
West Coast	6 651 921	6 965 448	5 331 085	13,296 533	10 960 977	1 335 556
Totals						

Source: Ray and Ray

Revenues and Expenses Year Ending Sept. 30, 1961

	OPERATING REVENUES				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non mail	Mail and Subsidy	Total		
Allegheny	12 349 983	13 208 502	8 250 549	21 459 071	19 458 036	2 001 043
Bonanza	5,372 796	5,593,280	3 370,891	8 964,161	7 985 170	978,991
Central	3,181 411	3,498,939	3,631 738	7 130,669	6 996,895	133 774
Frontier	7,042 457	7 674 108	6 038 442	14,512,550	13 738,596	773 954
Lake Central	4,631 358	4,905,596	3,444,598	8 350,286	8,211,567	138 719
Mohawk	11 569 069	12 441 178	4 678 690	17 319,856	16 043,234	1 276 624
North Central	15 029 111	16 029 571	8 046 652	24 076,403	23 754,151	322 252
Ozark	7 998 618	8,701 339	4,330,849	13 932,189	13 312,659	619 549
Pacific	6 157 594	6,901 273	4 518 398	11 419,663	10 527,912	891 751
Piedmont	8,040 344	8,749 783	4,543 217	13,313,099	12 531,983	781 016
Southern	5 400,759	5,776 252	4 268 440	10,044,712	9 667,900	376 812
Trans-Texas	5 291,434	5,783,136	3 813 091	9,595,227	9 461 663	133 564
West Coast	6 557 101	6,859 433	5,344,945	12 204,378	10,653,788	1,550 590
Totals	98 642 055	106 342 189	64 979,976	171 322,165	161 343 518	9 978,647

Source: Ray and Ray

a total of 79 stations added, 50 generated less than four passengers and only 20 produced six or more a day

Similarly, the Board deleted 15 points which generated less than four per day in 1960, but added 24 points which produced under four. Of the 42 added in that year, only 14 generated six or more daily passengers, ALTA said

The industry's average load factor has fallen, but most of the decrease has been on DC-3 equipment. Load factors on the more modern piston engine and turboprop aircraft have done well, ALTA said, considering the type of markets into which these aircraft operate

To aid re-equipment, CAB support was asked in extending and raising the limits of the Guaranteed Loan Act for aircraft purchases. Joseph P. Adams, ALTA executive director, urged an extension for five years to cover loans up to $10 million. Carriers which have taken advantage of the guarantee have gained lower interest rates over a longer term than could have been obtained without the CAB support, he said

Skeptical Operators

Considering the congressional scrutiny of subsidy and heavy route gains and nearly completed re-equipment programs of the group there are many local service operators who are skeptical that CAB will entertain any further proposals for route expansions or more new and expensive aircraft at this time. Among this group, many feel that the local service airlines would do well to consolidate their gains until the overall financial climate for the entire airline industry improves

Strong indications that this pessimistic attitude might be well founded became apparent last November at an aviation symposium conducted by the Connecticut General Life Insurance Co. at Hartford, Conn.

Alan S. Boyd, chairman of the CAB, said then that the Board might sympathize with the local service industry's demands for more profitable routes if trunk airline earnings were as high as they were in 1955

"But I for one," he said, "would not want to put the trunks in a bucket by expanding the subsidized carriers."

Criticism of the local service industry also came from Northwest Airlines President Donald Nyrop, who contended that the smaller carriers were diverting extensive traffic from trunk competitors. He added that the locals are studying short-haul pure jet aircraft and to support these aircraft are seeking access to relatively short haul, high density markets now served by the trunks

Hopes of the local service operators for more route expansions also drew little support from a panelist represent-

Local Service Airlines

Comparison of operating statistics years 1960 and 1961

	1960	1961	INCREASE 60/61 Amount	Per cent
Revenue Plane Miles (000)	94,792	104,349	9,557	10 1
Revenue Passenger Miles (000)	1,170,779	1,365,789	195,010	16 7
Originating Passengers	5,695,956	6,554,433	858,475	15 1
Enplaned Passengers	6,056 057	6 938,467	882,410	14 6
U S Mail Ton Miles	2,714,125	3,355,263	641,138	23 6
Express and Freight Ton Miles	6,272 201	8,513,469	2,241,268	35 7
Average Passenger Load (Persons)	12 4	13 1	0 7	5 6
Passenger Load Factor %	42 3	41 8	(0 5)	
Total Revenue Ton Miles (000)	121,174	142.427	21,253	17 5
Ton Mile Utilization (%)	42 9	43 2	0 3	
Average Revenue Load (Tons)	1 28	1 36	0 08	6 3
Performance Factor (%)	97 0	96 9	(0 1)	
Revenue Hours	606,111	651,090	44,979	7 4
Off-On Speed (mph)	156 4	160 3	3 9	2 5
Number of Departures	1,028,819	1,129,552	100,733	9 8
Average Length of Hop (Miles)	92 1	92 4	0 3	0 3
Daily Aircraft Utilization	5:33	5:24	(0:09)	(2 7)
Average Length of Journey:				
Originating Pssgr	206	208	2	1 0
Enplaned Pssgr	193	197	4	2 1
As of Fourth Quarter:				
Number of Aircraft	309	353	44	14 2
Number of Employes	12,413	13,479	1,066	8 6
Number of Stations	512	550	38	7 4
Route Miles Operated	47,473	52,084	4,611	9 7

Source: Ray and Ray

Local Service Aircraft

4th Quarter, 1961

Carrier	DC-3s	Convairs	Martins	F-27s	Total
Allegheny	7	13[1]	15		35
Bonanza				9	9
Central	18	4			22
Frontier	23	8			31
Lake Central	22	5			27
Mohawk	4	19	9		32
North Central	32	10			42
Ozark	23			3	26
Pacific	7		10	6	23
Piedmont	17			8	25
Southern	26		3		29
Trans-Texas	23	8			31
West Coast	14			7	21
Totals	216	67	37	33	353

[1]Includes Five Blond Powered 540's
Source: Ray and Ray

ing a New York investment banking firm. The spokesman, William B. Harding of Smith, Barney & Co., said he was optimistic that the smaller operators could, without competition and with a higher rate structure than the trunks, achieve a subsidy free operation, provided "they don't get too fancy ideas."

Permitting their entry into high density traffic markets would make it impossible to solve the current problem of excessive competition, he added.

Shortly after appearing at the symposium Boyd sent a letter to all local service airline presidents, setting forth CAB's ideas on subsidy reduction. Boyd asked the carriers to devote special attention to reducing subsidy by two methods.

The first he suggested was the suspension of service at unproductive points. His second conclusion was that "it appears that the point has been reached where the addition of capacity, either through the scheduling of additional flights or the operation of larger type aircraft, should be considered most carefully."

Calling attention to the industry's average load factor, which dropped from 45.73% in 1958 to 41.76% in 1961, the chairman contended that overcapacity, combined with the higher plane mile costs of more modern equipment, had increased subsidy.

To offset this adverse impact on subsidy, he asked the airlines to pursue with full vigor a management policy of tailoring or feeding in capacity at a slower rate than traffic growth.

These figures illustrate the strong impact exerted on the industry's operations, last year, by the combination of new routes and flight equipment, along with the class mail rate system:

- **Net operating revenues** climbed from the $142.9 million of 1960 to $177.6 million last year.
- **Total operating expenses** increased to $168.3 million from the $144.8 million recorded in 1960.
- **Net operating profit** reached $9.3 million last year, as compared with a net operating loss of $1.9 million for the previous year.
- **Mail and subsidy payments** which amounted to $52.5 million in 1960, increased to $65.2 million last year.
- **Breakeven need,** the difference between non-mail revenue and operating expenses, increased only $1.5 million for a total of $55.9 million last year, as compared with $54.4 million for 1960.

Over-all revenue ton mile load factor, which takes into account all forms of commercial revenue carried by the airlines, has held up exceedingly well, the industry feels. At 43.5% for 1961 this load factor was only 1% below that of 1958.

Rise Forecast in Air Cargo Growth Rate

By David H Hoffman

Professional forecasters in the field of air cargo have shed last year's pessimism and now predict 1962 growth rates ranging from 12 to 30% for an industry stimulated by minimum rate revocation, the advent of turbine-powered freighters and a stronger U. S. economy.

U. S. airlines, their own confidence bolstered by the 13% growth rate contained in the 1961 traffic statistics, have focused their technical attention on how to cut terminal handling costs. For the all-cargo carriers, these expenses average 40% of an air shipment's total cost. For the trunklines, 50% is the comparable figure. Profit possibilities, airlines believe, are inherent in the fact that neither percentage has changed substantially for the past five years.

But chances appear dim that many carriers will invest heavily in the mechanization of terminals or the construction of new ones designed from the start for cargo until 1962 can answer two questions What will be the short-term effect of the Civil Aeronautics Board's order revoking minimum freight rates? And, what business damage will result from President Kennedy's proposal to levy a 5% tax on all waybilled freight, assuming the proposal becomes law?

Industry, last year, was made aware that even with fully depreciated piston equipment, an inventive and aggressive management, and turbine-powered freighters, direct operating costs (DOCs) can be pushed down only so far To indicate the elasticity available, current Douglas DC-7F and Lockheed 1049H DOCs slide from 8 to 14 cents per ton mile, depending on company load factors and aircraft utilization rates

Under optimum conditions, the swing-tail Canadair CL 44 turboprop freighter and the Lockheed C 141 turbojet transport—when it becomes available in the mid 1960s—are designed to operate with DOCs of from 4 to 5 cents per ton mile At best therefore, the DOC difference between the two classes of aircraft represents a potential overall cost saving of about 25%

Flying Tiger Line which has yet to introduce the CL 44 in domestic service, feels that it can realize the bulk of this cost saving with its 10 new freighters Despite acute learning curve problems and some aircraft problems, it filed a complicated but drastically reduced class rate tariff with CAB—the first to follow minimum rate revocation

Trend Reversed

Tiger's tariff became effective on Oct 16 and reversed a downward trend in ton-mile volume then being experienced by the airline In the first three weeks under the new rates, Flying Tiger 1049H freighters carried 4,299,259 ton miles of cargo, or 23% more than during the same period of the preceding month

More important, the filing of the class rate tariff triggered a rash of competitive filings that underscore just how far apart industry is on how the growth of air freight should best be promoted Here are the three major rate philosophies advanced in the filings

• **Flying Tiger Line,** in order to exploit the CL-44's ability to carry payloads of up to 70,000 lb within a relatively cramped cargo envelope adopted the class rate Under it, freight is divided into seven categories based on average weight per cubic foot The greater this density the lower the rate charged by Flying Tiger Average rates are reported at about 13 5 cents per pound or about 27% less than the previous average of 18 5 cents Maximum rate reduction is 37%

• **American Airlines,** moving in the opposite direction, sought approval for a new tariff under which almost all products would move at an identical rate A new "off-peak" service rate applicable to cargo received between 9 a m and 3 p m for shipment along major long-haul routes also was proposed Off-peak rates undercut American's single rate by about 25%. The streamlined tariff, which included volume discounts or "weight breaks," was designed to stimulate shipments by simplifying price computations according to American spokesmen

• **United Air Lines** apparently sought to make its new rate the most attractive for air freight forwarders, who generate about 30% of all U S shipments To match Flying Tiger, United reduced most of its specific commodity rates and made them apply to a longer list of items But it also proposed weight breaks at the 1, 2 and 3,000 lb levels, which Flying Tiger did not thus creating volume discounts for forwarders. Average yield for United also would be about 13.5 cents per ton mile

Numerous protests and counter-protests were filed with CAB in the wake of these three tariff proposals Ordering an investigation of each concept, the Board suspended the rate structures filed by United and American On the subject of off peak rate reductions of 25%, the Board said in a preliminary finding that these would present a serious danger of uneconomical diversion of traffic and of unwarranted dissipation of carrier revenues"

Industry interpreted this reaction as clear evidence that the Board would not permit return of the ruinous competition that led to its original minimum rate order in 1948 But at the same time, because the Board did not allow the new tariffs to be tested industry could not assess the precise effect of lowered rates on air cargo movements This was true even though CAB approved reductions, on an item by item basis, in specific commodity rates charged by certain carriers

After analyzing the tariffs of Flying Tiger, United and American, CAB may decide to publish guidelines designed to warn carriers on the verge of filing new rates what the Board will or will not accept, according to CAB staff sources In itself, this would represent a substantial saving for the requirements of filing—and the legal maneuvering that often comes afterward—make rate experimentation a costly process

Optimistic forecasts of the professionals in air cargo are based in part on 1961 statistics According to year-end estimates of the Air Transport Assn, freight traffic carried by all U S airlines increased 12 62% in 1961 to reach a record 724,800,000 ton miles Concurrently, U S mail traffic jumped 22 28% to 294,200,000 ton miles Express ton miles were up 0.51% to 59,400,000.

These increases, ATA said, pushed the total property carried by certificated U S carriers over the one billion ton mile mark for the first time in history

Airlines consider it significant that these records were set during the same year the industry lost an estimated $30 million after taxes and total passenger miles increased only 1 1%. Aware that only 0.05% of total inter-city ton miles of freight moves by air, carriers are showing renewed interest in turbojet freighter designs now collecting dust on the drawing boards of major manufacturers. Trans-Canada Air Lines, as associate member of ATA, placed a $30 million order late last year for four Douglas DC-8F turbojets, the first civil turbojet freighters to be sold by a U S company

Strong evidence also exists that the 1961 upturn in air cargo movements has carried over into 1962 American Airlines, which leads the trunks in cargo carriage, hauled 11 million ton miles of freight in January or almost 26% more than in January 1961 United Air Lines reported a 15% increase in January based on 8,981,000 ton miles Delta Air Lines said January freight movements were up 57% over last year

Air Cargo, Inc., the pickup and delivery service owned by ATA airlines conservatively estimates that 1962 movements will exceed those of 1961 by about 12%. To illustrate Air Cargo's accuracy in this area, it had forecast a 14 4% increase for 1961 over 1960 Actual movements were up about 12 5%, as were over-all certificated air line movements reported by ATA

Stanley H Brewer, Professor of Transportation at the University of Washington and a market analyst for Boeing Aircraft Co, apparently feels

RIDDLE AIRLINES' ARMSTRONG WHITWORTH AW 650 ARGOSY

Air Cargo in Scheduled Service 1960-1961

	THOUSANDS OF REVENUE TON-MILES					
	Mail		Express		Freight	
	1961	1960	1961	1960	1961	1960
DOMESTIC TRUNK LINES						
American	26,214	23,454	11,872	12,059	125,016	112,325
United	48,000	36,543	14,943	11,416	101,346	77,143
Trans World	18,762	19,267	8,999	9,088	58,818	43,803
Eastern	16,352	14,794	6,486	6,419	27,725	21,622
Northwest	6,203	7,592	2,339	3,423	11,968	17,852
Delta	8,074	5,898	4,176	3,681	19,179	15,466
Braniff	8,159	5,136	2,267	1,978	11,174	7,476
National	4,565	3,949	898	794	12,155	8,023
Capitol	2,962	6,512	1,427	3,474	2,477	5,621
Western	3,385	3,846	1,114	1,199	6,026	4,060
Continental	3,155	2,362	1,516	1,420	7,359	5,127
Northeast	1,964	1,552	706	490	3,217	2,658
Total Trunk	147,795	130,907	56,745	55,441	384,460	321,176
LOCAL SERVICE LINES	3,355	2,714	3,019	2,419	5,495	3,853
ALL CARGO LINES						
AAXICO					26,723	35,758
Aerovias Sud Americana					2,891	5,660
Flying Tiger	365	652	382	667	137,348	105,112
Riddle	390	243	376	382	77,768	24,074
Seaboard & Western	12,417	9,150		217	51,032	40,836
Slick					42,879	54,595
Total Cargo	13,172	10,045	758	1,266	338,641	266,035

Source Ray and Bay

Air Cargo Traffic

Revenue Ton Miles

(THOUSANDS)

Year	Total[1]	Trunk Carriers	Local Service	All-Cargo Carriers	All-Cargo Carriers' Share of Total	Over-all Growth Rate
1956	391,310	240,301	3,311	148,112	37 9%	
1957	421,672	261,186	3,724	156,766	37 2	7 8%
1958	412,936	286,400	4,042	122,494	29 7	−2 1
1959	482,978	335,579	5,332	142,067	29 4	16 9
1960	507,071	376,389	6,266	124,416	24 5	5 0
1961[2]	563,500	430,500	8,400	124,600	22 1	11 1

1 Totals exclude Alaskan, Intra-Hawaiian, helicopter and international flag operators Cargo includes only freight and express.

2 1961 figures are year-end estimates of Air Transport Assn. based on actual data for first nine months and estimated data for the last three months

FLYING TIGER CL-44

the forecast of Air Cargo is unduly pessimistic. According to Brewer:

"Improved service, lower rates, and an aggressive attitude on the part of airline management ... can result in accelerated rates of growth for the future. It is entirely possible that [air cargo] will grow at an annual rate of 20 to 30% a year for the next 10 to 20 years. A 20% annual rate of growth would develop a 5 billion ton mile U.S. domestic market by 1970, a 10 billion ton mile market by 1975, and a 30 billion ton mile market by 1980."

A steady 20% growth rate during the next 10 years seems "very realistic" in view of recent trends and developments, Brewer said. But this growth rate, he cautioned, may prove somewhat optimistic over a 20 year timespan.

An even better potential can be found in international markets accessible to U.S. carriers, according to Brewer. This, he said, is because greater distances are involved. Ships travel slower than trains or buses, and overseas airline operators can reduce rates more drastically than domestic operators.

The predictions of Brewer rest heavily on the historical relationship between world air freight movements and the U.S. gross national product. Since 1946, the growth rate of one has risen proportionately to the growth rate of the other (AW May 1, p. 61). Barring prolonged recessions, an annual average GNP growth rate of about 4% is predicted by most economists for the next two decades. And historically, U.S. air freight grows at a rate five times greater than that of the GNP.

While this natural force is generating new business, airlines have embarked on a two-pronged sales effort, first to attract small shippers, and then to convince large manufacturers that total distribution of many products by air is cheaper than a network of warehouses. Currently, the average weight of the average air shipment is about 165 lb., indicating to many observers that airlines must give greater attention to the needs of small shippers in order to tap the mass market.

To illustrate the selective character of the industry, Flying Tiger President Robert Prescott reports that 31 shippers generate 75% of his airline's total business and have for the past five years. The aircraft industry alone accounts for about 15% of the total ton miles of air freight moved in the U.S. each year.

Private industry surveys show that in the foreseeable future only about 2% of the total ton miles moving between cities can be made to move by air. But this represents a 40 fold increase over the present percentage in an industry that has proven itself highly responsive to rate reductions.

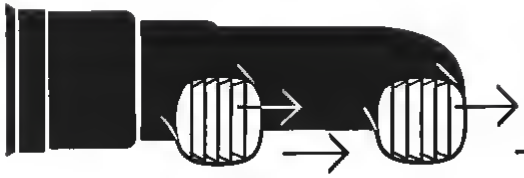
Indirect Costs

As carriers acquire efficient turbine-powered freighters and DOCs level off at about four cents per ton mile, indirect costs will be attacked with new urgency to permit added rate reductions. Flying Tiger Line, for example, is installing a mechanized cargo handling system for the CL-44.

According to Prescott, "It has taken 11 men one hour to load 25,000 lb., but with the new operation over 60,000 lb. can be unloaded and similar amount loaded in a total of less than one hour. From less than 2,300 lb. per man-hour, productivity will be increased to over 40,000 lb. per man hour."

Decrease in unit cost that results is apparent from the fact that each CL-44 has a fixed cost of $2,500 per day for depreciation, insurance and taxes. When utilized eight hours per day, cost of ownership is more than $300 per hour. But if utilization is stepped up to 16 hr. per day, hourly costs drop to about $155, a saving of over $150 per hour or 1.25 cents per ton-mile capacity.

AERO POWER



FOR V/STOL AIRCRAFT

SIMPLIFIED POWER

Bristol Siddeley lift/thrust turbofans are the optimum power units for all V/STOL applications because the total thrust can be used for both lift and forward propulsion. They permit the simplicity of a single-engine installation or, used with separate lift engines, they provide a simpler and more economical solution than can be achieved with any combination of separate lifting and propulsion engines.

SINGLE-ENGINE INSTALLATION

* Simplified installation.
* Simplified aircraft control
* The resultant thrust and intake drag passes through a fixed point near the aircraft centre of gravity
* Maintenance and spares requirements are confined to one engine.
* Availability of a large power reserve for acceleration and manoeuvre.

MULTI-ENGINE INSTALLATION

* Fewer specialised lift engines required as the total propulsive power is also available for take-off.

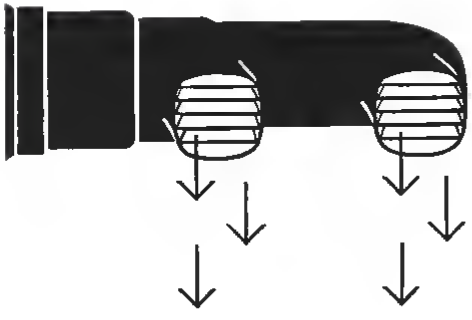
SUPERSONIC FLIGHT

In Bristol Siddeley lift/thrust turbofans fuel can be burned in the by-pass ducting or plenum chamber to give a thrust boost for take-off and supersonic flight. This plenum chamber burning permits:

* A large thrust boost for supersonic speeds with only a modest increase in specific fuel consumption.
* Engine performance matched to aircraft cruise requirements
* Greater thrust for transonic acceleration
* Greater radius of operation

These thrust boost advantages are achieved more economically by plenum chamber burning than by reheat in the hot exhaust gases.

The development of Bristol Siddeley lift/thrust engines is supported by the US Government through the Mutual Weapons Development Programme



BRISTOL SIDDELEY ENGINES LIMITED For further information please write to the Sales Manager Aero-engine Division, Bristol Siddeley Engines Limited PO Box 3 Filton Bristol England

Aeroflot Gains in World Leadership Drive

Russia's drive for world air transport leadership accelerated sharply during 1961 as Aeroflot made major gains in traffic while improving the quality of its service.

Last year the Soviet airline monopoly carried around 22 million passengers, according to G. S. Schetchikov, first deputy chief. This is 36% more than the approximately 16.2 million passengers handled in 1960.

Goal for 1962 is nearly 30 million passengers. The Soviet Seven-Year Plan target of 50 million passengers in 1965 will be surpassed even if Aeroflot's growth rate drops below 20% after 1962.

Early this year, Aeroflot Chief Yevgeny Loginov announced a new, long-range goal of 200 million passengers annually by 1980.

Russia's 1961 traffic gains came at a time when recession-hit U.S. airlines were showing only a small decrease in passenger business as compared with 1960 and the overall passenger gain for the 90 member nations of the International Civil Aviation Organization was only 6%.

Traffic Increase

If Russia achieves its objective of 5 million more air passengers in 1962 than in 1961, American carriers will have a 14% traffic increase to keep pace in terms of percentage. This is considerably more than the most optimistic U.S. airline executives are predicting.

Schetchikov asserts that during the past eight years, average annual growth of Russian commercial air transportation has been 3.6 times higher than in the United States. As recently as 1956, Russia was carrying only 7% as many air passengers as the United States, the world's leader. This proportion grew to 11% in 1957, 17% in 1958, 22% in 1959, 28% in 1960 and 35% in 1961.

On a global basis, Russia, which is not a member of the International Civil Aviation Organization, carried only 4% as many passengers as all ICAO members combined in 1956. In 1961, this figure rose to nearly 20%.

Other data recently released by the USSR after a decade in which few meaningful figures were provided and some statistics were deliberately misrepresented show that Aeroflot:

- **Carried more than 60%** of its passengers in jet or turboprop aircraft during 1961.
- **Has a domestic route network** of about 248,000 mi.—the largest in the world. In addition, there are 49,860 mi. of Soviet international routes.
- **More than doubled** the number of passengers carried on foreign routes during the past two years.
- **Provided direct service** between Moscow and 24 world capitals by early 1962.
- **Possessed sufficient seat capacity,** according to Premier Khrushchev, to handle up to 100,000 passengers daily, as of the fall of 1961.
- **Expects to expand** its domestic route network to 310,500 mi. by 1980 and to increase mail and cargo traffic fourteenfold in the next 20 years.

Tu-114 Into Service

Aeroflot boasts that no other airline in the world has as many modern jet planes. During 1961, the Soviet carrier greatly enlarged its fleet of Il-18 and An-10 turboprops, placed the giant, four-turboprop Tu-114 in regular service, and began test flights with the long-range model of the Il-18.

At the same time a number of early-model, twin-jet Tu-104s were taken out of passenger service and placed on high-speed mail-cargo runs.

The Tu-114—world's largest transport—finally went into scheduled nonstop service between Moscow and Khabarovsk, 4,350 mi., in April, 1961, after a long series of delays. Initial flight frequency was twice weekly. This was increased to one round trip daily by year end. Twice-daily Tu-114 runs between Moscow and the Far East are promised sometime this year.

Because of their low trip frequency initially, Tu-114s carried only about 25,000 passengers during their first eight months in scheduled operation.

Tu-114s in service last year were the 170-passenger version. However, the 220-passenger configuration continued to be mentioned prominently as Aeroflot publicists stressed the airplane's enormous capacity.

TU-124 TWIN-TURBOFAN TRANSPORT

The experimental Il-18-I is identical in outward appearance with conventional Il-18 turboprops. But the entire center wing section is used as a fuel tank to provide longer range. It carries 14 more passengers than the Il-18, accommodating as many as 125 persons in the tourist version. The airplane has flown from Moscow to Vladivostok nonstop, nearly 5,000 mi., in 11 hr. 15 min.

A new, high-density, 132-passenger version of the four-turboprop An-10 transport was tested during 1961 and was expected to be ready for service by year end or early 1962. Improvements in cabin arrangement and seat design permitted addition of 32 seats to the An-10's conventional 100.

An-10 service was inaugurated on more than 20 of Aeroflot's domestic routes last year alone. Il-18s were serving 45 Aeroflot routes as of last July.

Both the Tu-114 and An-10A claimed new world records during 1961. In April, an An-10A flew more than 730 kilometers per hour (453 mph.) over a 500-kilometer closed course. Top speed was over 750 kph. (466 mph.).

During July, a Tu-114 set three altitude with load records by lifting 30,035 kilograms (66,215 lb.) to a height of 12,535 meters (41,125 ft.).

Aeroflot's two newest transports—the twin-jet Tu-124 and twin-turboprop An-24—did not go into scheduled service during 1961 as planned. Both were unveiled in the spring of 1960.

Aircraft Delays

Since introduction of the twin-jet Tu-104 in September, 1956, no new Russian transport has met its target date for regular service. In the case of the Tu-114, the slippage was about two years.

Tu-124 was apparently nearing operational status by early 1962. A first-class, 44-passenger version was making proving flights on the 932 mi. Moscow-Sochi run at average speeds of more than 465 mph.

With the large increase in Il-18 and An-10 operations during 1961, Aeroflot's ton-mile costs reportedly dropped slightly. At the same time, Ekonomicheskaya Gazeta, an official organ of the USSR Communist Party's Central Committee, made a frank, if belated, admission that the Tu-104 was a far-from-economical commercial transport.

Five years after the twin-engine Tu-104s were introduced by Aeroflot with much fanfare as the world's first scheduled jetliners, they were openly criticized for what was called their considerably below-standard productivity. It was conceded that low utilization, excessive ton-mile costs and high depreciation have more than offset the Tu-104's speed advantages now that the aircraft has a diminished prestige value.

Aeroflot's own house organ, Grazhdanskaya Aviatsiya, was slow to learn the party line. For some time afterward it continued to maintain that the Tu-104 had the lowest ton-mile costs of any Soviet commercial transport.

Ekonomicheskaya Gazeta went on to complain that on a run with three intermediate stops the Tu-104 usually spends 25-30% of its time in flight and the remaining 70-75% standing at airports.

"Unproductive, idle time is increasing on Tu-104 aircraft which are in good repair and ready for use. One of the reasons is that heavy-type planes have limited ability to take off and land in bad weather.

"At present, transportation outlays and depreciation reserves being used for replacement aircraft and for capital

AN-24 TWIN-TURBOPROP TRANSPORT

TU-114 PASSENGER CABIN

repair of the air fleet are still very large. [In 1960], depreciation costs comprised about one-fourth of Aeroflot's transport expenses.

"This is explained by the fact that modern aircraft with gas turbine engines are expensive to manufacture because of their complex design and great weight. If we compare the weight of the first [Soviet] civil jet plane—the Tu-104A—with a foreign jet such as the Caravelle, we find that the latter is considerably lighter but has almost the same productivity.

"The modified [100 passenger] Tu-104B now has more productivity than the Tu-104A. However, the Tu-104B's weight is still too great."

Despite this shattering of the Soviet propaganda image of the Tu-104, the aircraft flew more ton-miles and more passenger-miles than any other Aeroflot transport last year. In July, 1961, Tu-104s, including the 100 passenger B model, were handling 40% of the Russian carrier's total transportation work.

For the year as a whole, Tu-104s flew about 33% of Aeroflot's ton-miles. Last September, on their first anniversary in scheduled operation, Tu-104s were serving 40 domestic and 13 international routes.

Ekonomicheskaya Gazeta said the best opportunities for reducing Aeroflot's operating costs lie in longer periods between airframe and engine overhauls and in improved utilization.

"By doubling the present period between servicings of planes and engines, we can cut [overall] transportation costs 15-20%. Outlays for depreciation can be considerably reduced by improving the quality and reducing the cost of complete overhauls at Aeroflot bases.

"Automation of radio communication and radio navigation facilities could free a considerable number of service personnel. Special attention should be paid to mechanized ground servicing for aircraft.

"Existing refueling methods for turbojet and turboprop planes are not efficient. It would be several times more productive and cheaper to have special, fixed refueling points supplied by pipelines."

Aeroflot officials continue to talk with studied vagueness about supersonic transports. Deputy Chief Schetchikov declared last fall, "Our designers are busy on them, so be prepared." While refusing to predict the date when Russian supersonic airliners would go into service, Gen Loginov vowed that, "We will not lag behind [other nations]." Loginov indicated that Russia's first supersonic commercial transport would not be a converted military plane, but an original design.

Schetchikov has also emphasized Aeroflot's need for "special cargo aircraft capable of delivering large-dimension loads to the sites of new construction projects in remote areas of the USSR. His statement indicated that cargo versions of the four turboprop An-10 and An-12 are not adequate for the purpose.

Regardless of whether Russia develops more-advanced commercial transports before the end of the Seven-Year Plan in 1965, Aeroflot seems certain to become a major factor in international air transportation by that date. Increasing Cold War tensions prevented the signing last summer of a bilateral air transport agreement between the U.S. and USSR for Moscow-New York service. But quick implementation of the already-initialed pact is likely to follow any real thaw in Soviet-American relations.

With service expansion across the North Atlantic temporarily blocked, Aeroflot focused attention on southeast Asia.

In November, Russia and Indonesia signed an agreement providing for direct air service between Moscow and Djakarta. Scheduled weekly Il-18 flights over the 6,500-mi. route began late in January. Intermediate stops are at Tashkent, Delhi and Rangoon.

Aeroflot hopes to extend this link on to Australia, New Zealand and Soviet bases in Antarctica. Flight of an Il-18 and An-10 from Moscow to Antarctica, 14,700 mi., in December and the return trip in January blazed the trail for this route. Intermediate stops beyond Djakarta were at Darwin and Sydney, Australia, and Christchurch, New Zealand.

Prospects are also good for inauguration this year of scheduled Aeroflot operations down Africa's west coast. Russia and the Republic of Guinea signed an agreement in January providing for establishment of air service between the two countries.

Domestically, Aeroflot is giving high priority to construction of the huge Domodedovo airport south of Moscow and to Borispol airport near Kiev.

To ensure domestic passenger increases commensurate with rising air lift and ground terminal capacities, Aeroflot has begun to experiment with promotional fares. On Jan. 1, 1962, the carrier announced a 25% tariff reduction for students buying round-trip tickets for nonstop jet or turboprop flights between their places of study and their home districts.

A widely discussed Aeroflot traffic promotion innovation last year was the use of cheesecake posters to stimulate air travel to and from Black Sea resorts. The Soviet press said that the appearance of some of these posters right beside railroad ticket counters represented "a resolute attack by Aeroflot on its railroad competitors."

PASSENGERS CARRIED
(In Millions)

Year	U. S.*	USSR‡
1961	57.6†	22.0
1960	57.7	16.2
1959	55.9	12.4
1958	49.1	8.4
1957	49.3	5.4
1956	45.9	3.2
1940	3.0	3

* Scheduled airline industry.
† Estimated.
‡ Figures for years prior to 1961 based on announced annual percentage gains.

LUFTHANSA BOEING 720B JET TRANSPORT

World Airlines Hope for 1962 Traffic Rise

World airlines in 1961 generally were pinched financially by a slowed growth in traffic just as capacities swelled to new highs with entry of fleets of jet aircraft into service.

Last year, patterns of jet service had been established over world-wide routes. But passengers were not forthcoming to fill the greatly expanded seat totals.

International Air Transport Assn Director General William P Hildred spoke of "a faltering in the normal rhythm of growth" of world air transport in 1961, with an over-all passenger increase of only about 6% But he said there are signs of a recent pickup in the tempo of growth and predicted a 1962 traffic increase of about 12%

Observers felt that the big capacity burst of 1961 would not be matched this year and so load factors should be due for an improvement

One indirect long-range effect of the overcapacity problem, however may be the final implementation of the European Air Union as an effective cooperative instrument on both operational and administrative levels in place of the loosely knit debating society it has resembled thus far Need to spread the cost of new equipment purchases and subsequent maintenance, including effective spares pools was forcibly brought home last year as expected traffic growth failed to materialize and jet-age costs mounted

Air Union Quota

There were growing indications that the four carriers now involved, despite lingering objections in some quarters, are prepared to accept the present quota distribution giving Air France 34%, Lufthansa 30%, Alitalia 26% and Sabena 10%

KLM Royal Dutch Airlines, which resigned from the group in 1959, hopes to find an avenue for re-entry after sustaining substantial losses in 1961 that forced it to ask for increased government aid Lufthansa, on the other hand, feels that the quotas should remain as they are without the necessary redistribution a new membership would entail, until Air Union can be definitely established as a going concern

Highlights of commercial aviation around the world in 1961 included

Czechoslovakia

CSA Czechoslovak Airlines, largest of the East European carriers reports a steady growth in its operations during 1961 and plans further route expansion this year

Total ton miles flown last year were 35,481,630 compared with 14,960,400 ton miles in 1958, 10,370,900 in 1957 and 8,679,635 ton miles in 1956

The Czech carrier also is meeting with some success in its attempt to compete with Western operators on their already established South American routes and in Africa, where newly independent states are concerned with improving their air services and the political climate is receptive

With a 94-passenger Bristol Britannia turboprop aircraft leased from Cubana Compania de Aviacion early this year, the carrier began a once-a-week round-trip service between Prague and Havana via Shannon and Gander, Newfoundland, for an indefinite period of time

In addition, CSA introduced on Feb 15 a second new route extension between Prague and Damascus via Sofia and Ankara which, with the Prague to Baghdad via Athens and Damascus service inaugurated in June, 1960 now is served on a twice-a-week round-trip basis with its Soviet Il-18 turboprop transports

The Czech airline already serves more than 25 major non-Soviet bloc centers from its Prague Ruzyne Airport base of operations

In addition to a few Douglas DC-3s operated on feeder services for the airline's shorter domestic routes, CSA depends primarily upon Soviet-built Il-14s Il-18s and Tu-104A twin-jet transports for its international and longer national route network, although some of its Il-14s now in service were built under license by Avia Aircraft Works, Prague

France

Of the Air Union partners, Air France continued to lead in number of passengers and passenger miles Over its entire route structure the French airline carried 3,600,000 passengers representing a moderate gain over 1960 but not enough to absorb the capacity increase

Even so the airline is anticipating substantial increases for the future and last year placed orders for seven additional Sud Caravelle medium-range transports and four Boeing 707-320Bs With the final arrival of these aircraft in 1963, Air France will have a long- and short-range jet fleet consisting of 64 planes

Major event in French commercial aviation during the year was announcement of a merger of Union Aeromaritime de Transport (UAT) and Transports Aeriens Intercontinentaux (TAI) It is expected that the fusion of the two private carriers will take approximately two years to complete

UAT carried 203,200 passengers in 1961, a 1% increase over the previous year UAT freight loads for the year were down 24% and system-wide load factor was 63%

UAT network extends primarily from Paris to Johannesburg with stops in southern France and northern and western Africa UAT, along with Air France, is taking an active part in the establishment of Air Afrique, a West African airline jointly owned by former French West African territories

TAI carried 119,200 passengers in 1961, a substantial 38% increase over 1960 The increase reflects inauguration of the carrier's service between Tahiti and Los Angeles

TAI's main route—one of the world's longest—runs from Paris through the Middle and Far East, Australasia, Tahiti and Honolulu, linking in Los Angeles with Air France System-wide load factor for 1961 was 57%

The merged UAT TAI group will operate with a fleet of about 40 aircraft, including five Douglas DC-8 jets and two DC-7s

The combined line will serve 41 countries with stops over an unduplicated network of 120,000 mi

Great Britain

Developments in the British air transport industry during 1961 and early 1962 pointed to the increasing importance of merged independent carriers as a third major airline in a field long dominated by British Overseas Airways Corp and British European Airways both state-owned enterprises

The trend was clearly indicated when British United Airways, largest independent, joined forces with competitors to consolidate fleets and routes and to make a more forceful showing before the Air Transport Licensing Board Primary reason for the move toward consolidation is the fact that the Air Licensing Act of 1960 has not provided the small airlines a greater share of the traffic total as it originally was designed to do

Although the board last year approved a London New York route for Cunard Eagle, a large independent, Minister of Aviation Peter Thorneycroft—who has the final decision under the act—denied the route to Cunard Eagle on the grounds that it would cause wasteful diversion from BOAC at a time when that airline already was suffering heavy losses

The independents fear the Thorneycroft decision will set the pattern for

peak traffic routes. Hence, they have decided to combine forces to strengthen their case both from a financial point of view and through fleet buildups.

Financial strengthening was an immediate necessity. Licensing board has served notice it would take a hard look at independent financial stability before awarding routes. In 1961 alone, seven small airlines went into receivership.

Future of Cunard Eagle is uncertain, although a merger with British United is widely expected.

Factor dominating the entire transport issue is the earning capacity of BEA and BOAC. Sir Basil Smallpeice, BOAC's managing director, has reported a 1961 loss of $30 million, much of it resulting from a North Atlantic season he has described as disastrous.

At BEA, Chairman Lord Douglas of Kirtleside said the airline may face a deficit even though it carried a record 4.3 million passengers in 1961. Capacity rose 21%, but revenue load factor fell more than five points to 60.9%.

BOAC plans to cut its capacity on the North Atlantic this year by 7%, but this will not apply to the peak summer months, when capacity will increase by about 15%. During the peak period, BOAC will operate 37 Boeing 707-420 and 14 Bristol Britannia flights a week each way for a total of 6,595 seats, compared with 5,844 seats last summer.

BEA also will increase its peak season seating. Reflecting increasing interest in Spain as a tourist center for Britons, BEA will fly for the first time between London and Malaga. However, the service will involve a revenue pooling agreement with British United.

A battle between airlines and the Ministry was developing at London (Heathrow) and Gatwick airports. Thorneycroft seeks to reduce night jet takeoffs, a restriction BEA says would completely disrupt its maintenance schedules. The minister's efforts result from increasing pressure from noise complaints. A large group of Heathrow residents has mustered considerable parliamentary support.

Legislation presently is being prepared to provide an authority to take over control of London's airports from the Ministry. The job is expected to take most of this year.

Holland

KLM estimates its 1961 losses at between $19.4 million and $22.2 million, a substantial blow for this national carrier to absorb. In January, KLM was forced to apply formally for government subsidy to help it overcome its present difficulties and to continue its jet reequipment program.

The major problem, again, was capacity, which jumped 21% during the year with additional Douglas DC-8 deliveries, while the traffic earned was only 12% above that of 1960.

After its subsidy request, KLM was told by the Dutch Minister of Transport that, in view of mounting costs, it must join some share-the-burden airline consortium in an effort to relieve the present situation. KLM had been seriously considering the possibility of joining the Swissair Scandinavian Airlines System bloc over the past two years, but it now hopes to turn to the Air Union.

India

Air-India International increased its jet fleet in 1961, adding Boeing 707-420 equipment to a number of routes. Total revenue passengers carried rose from 89,385 in Fiscal 1959-60 to 124,951 in Fiscal 1960-61.

The carrier showed an operating profit of $2,466,000 in the latter fiscal year up from $383,000. Ton-kilometers operated rose from 59,518,000 to 161,447,000.

With delivery of two more jets this month and next, bringing the total to six, Air-India will be an all-jet operator on all its routes. New services planned this year include a New Delhi-Moscow jet service via Tashkent. This will replace Super Constellations and pool service with Aeroflot Tu-104s. The 707-420 service is scheduled for inauguration next month.

Air India's load factor on the North Atlantic last year was a meager 32%. Improvement is expected in 1962, partly because of plans to increase to a daily service.

Italy

Alitalia underwent a period of considerable expansion in 1961, extending its long range routes and showing strong gains in traffic earned. Revenue passenger total on the airline's system rose 39% to 1,528,175. Passenger mile total was up 39.3% to 1,157,834,560, and cargo total increased 52% to 40,393,353 lb. earned. Passenger load factor for the system was 54.3% in 1961, down from 57.7% in 1960.

On the North Atlantic, Alitalia's passenger total was up 47% to 86,738. Load factor on the route was 51%.

During 1961, Alitalia introduced DC-8s on routes to South America, Australia and the Far East. It now serves 73 cities in 43 countries, flying over 93,676 unduplicated route miles.

The Italian carrier plans to inaugurate transatlantic service from Chicago next month with an initial twice-weekly schedule. This month, service from Rome to Buenos Aires will be extended to Santiago de Chile. Bilateral agreements have been concluded with Thailand and Japan, and service to Japan is expected to begin June 1.

Alitalia's present jet fleet consists of 8 DC-8s, used on international routes, and 10 Sud Caravelles, used in Europe, North Africa and Middle East service. Two DC-8s and four Caravelles are on order for future delivery.

Japan

Delivery of jet equipment enabled Japan Air Lines to greatly expand its operations during 1961 on both its international and domestic routes. In international, revenue passenger total increased 48% to about 149,300 passengers. The domestic total rose 60% to about 1,057,000 passengers.

During 1961 the airline's fleet grew to four DC-8s and three Convair 880Ms. A fifth, DC-8 turbofan powered and two additional 880Ms are scheduled for delivery this year.

Opening of new routes increased JAL's route mileage to 38,357 mi., a rise of 9,241 mi. New routes included a polar route between Japan and Europe, which had been operated jointly with Air France until Japan Air Lines got its own jets for the service. Jet service on the carrier's domestic network was inaugurated last September with the 880Ms.

During the year, JAL's capital was increased from $30,790,625 to $32,980,797, of which the Japanese government's investment totals $18,888,888.

A further 33% expansion of its international routes is planned this year as well as a 50% increase in domestic seat capacity.

For the future, Japan Air Lines expects to fly a new route to Australia and a round the world route by 1964.

Poland

LOT state-owned Polish Airlines, ranks about second among the carriers of any importance in East Europe. With mostly out-dated equipment, limited technical facilities and restricted financial resources it is having a hard struggle in its effort to expand.

Passengers carried by LOT in 1959 totaled 155,000 compared with 200,900 in 1960. Cargo carried in 1959 amounted to 3,360 U.S. tons. In 1960, 5,500 U.S. tons were carried.

The Polish carrier's international network now serves about 17 European centers, including Moscow and Vilna in the Soviet Union and covering a total distance of 7,968 mi. Its domestic network covers 1,121 route mi. In addition to three comparatively new Il-18s, LOT's fleet is composed of four Convair 240s, 12 Il-14s and 20 Li-2s.

Despite persisting difficulties, the Polish airline is working on plans to introduce its first transatlantic services, probably with four Vickers VC-10 transports, in the 1963-65 period.

LOT is presently considering the Russian Tu-124 jet as its next choice

The carrier also urgently requires a suitable replacement for its aging Il 14s and Li-2s presently serving its domestic network An order for several of the new Polish 20 passenger MD-12 piston engine feeder aircraft developed and built by the Instytut Lotnictwa (Aeronautical Institute) of Warsaw is expected to be placed soon

Scandinavia

Scandinavian Airlines System, which lost approximately $16 8 million in the fiscal year ending Sept 30, 1960, followed it with a $17 36 million deficit for the past fiscal year and expects further losses this year

The airline is under a caretaker management, headed by a Swedish industrialist Curt Nicolin, which has the task of introducing a sweeping reorganization program designed to cut administrative and operational costs and improve aircraft utilization rates First moves in this direction are under way, and Nicolin will extend his temporary tenure until a final plan is drafted and approved by the carrier's directors

Spain

Spain's Iberia Airlines is now in the throes of a long-expected top manage ment reshuffle in response to government demands, including eventual replacement of the full board of governors Dissatisfaction reportedly stems from the carrier's slow progress towards its goal of becoming a profitable, prestigious international carrier

Last year, however, Iberia became a major competitor in the transatlantic market with the delivery of three Douglas DC 8 turbofan transports. A fourth is to be delivered in September

Over-all, Iberia carried a total of 1,117,981 passengers during the year for a network load factor of 57 5% Passenger kilometers flown were 796 million compared with 1,382,000 available seat kilometers

Switzerland

Swissair rounded out the year in the black, if only barely, largely through the sale of surplus piston aircraft—five Douglas DC-7Cs and three DC-6Bs Without these sales a $1 million deficit would have resulted. Operationally, the airline registered a 20% gain in passengers carried for a total of 1 4 million Average load factor, however, was 54 8% as compared with 58 6% in 1960

With the delivery of five Convair 990 medium range transports this year, Swissair expects to improve its position over the South American and Far Eastern routes First 990 service to Buenos Aires, Rio de Janeiro and Montevideo began in late February

Aside from the five 990s it will operate, Swissair has purchased another two which is will lease directly to SAS in line with a pool agreement

West Germany

Continued expansion of routes and services of Lufthansa West German Airlines was experienced during 1961 and will highlight the carrier's activities this year (AW Feb 26, p 40)

Lufthansa's financial results for fiscal 1961 will show a loss of $25-31 million, compared with a $9 75 million deficit in Fiscal 1960 But traffic increased rapidly Lufthansa carried 1 5 million passengers in 1961, up 25% Ton miles flown increased 25% to 316 8 million, and freight carried increased 55% to 25,320 tons

On the North Atlantic, where reduced load factors contributed to the unfavorable financial results, Lufthansa nevertheless carried 123,224 passengers, moving for the first time to sixth place in traffic volume The 1960 passenger total was 97,986. Load factor on the route in 1961 was 56%

Lufthansa's jet fleet now consists of five Boeing 707 420s and three 720Bs Four additional 720Bs, two 707-320s and 12 727s are on order

Development of its air cargo services also is an important Lufthansa activity.

CHARRING ABLATOR made of phenolic resin and glass fiber undergoes a heating rate test at NASA's Ames Research Center. Charring ablative is probable re-entry heat shield for Apollo spacecraft

Specifications

U.S. Military Aircraft

Manufacturer	BASIC AIRCRAFT DATA			DIMENSIONS					WEIGHTS			POWERPLANT
	Military designation	Military name	Primary mission	Number in crew	Over-all span	Over-all length	Over-all height, 3 pt.	Gross wing area, sq. ft.	Weight empty lb.	Normal gross wt., lb.	Maximum gross wt. lb.	Number make model and max. rating ea.
Beech Aircraft Corp. *Wichita, Kansas*	L-23D	Seminole	Liaison Transport	1-2	45' 3"	31' 6"	14' 0"	241	4 460	7 000	7 300	2 Lyc. GSO-480 @ 340 hp
	RL-23D		Radar Recon	2	50' 3"	31' 1½"	11' 6"	253 9	5 954	7 350	4 350	2 Lyc GSO-480 @ 340 hp
	L-23F		Liaison Transport	1-2	45' 3"	33' 4"	14' 1"	274	4 440	4 700	4 700	2 Lyc IGSO-480 A1A6 @ 340
The Boeing Co. *Seattle, Wash*	B-47E	Stratojet	Med Bomber	3	116	109	28'				230 000	6 GE J47-GE-25 @ 6 000 lb. t
	B-52A B	Stratofortress	Hvy Bomber	6	185	152' 8"	48' 3"	4 000		350 000+		8 P&W J57-P-1W @ 10 000 lb.
	B-52C D E	Stratofortress	Hvy Bomber	6	185	152' 8"	48' 3"	4 000		450 000+		8 P&W J57-P-29W @ 10 000 lb.
	B-52F	Stratofortress	Hvy Bomber	6	185	152' 8"	48' 3"	4 000		450 000+		8 P&W J57-P-43W @ 13 750 lb.
	B-52G	Stratofortress	Hvy Bomber	6	185	157' 6"	40' 8"	4 000		488 000		8 P&W J57-P-43W @ 13 750 lb.
	B-52H	Stratofortress	Hvy Bomber	6	185	157' 6"	40' 8"	4 000		488 000		8 P&W TF-33-P-3 @ 17 000 lb.
Cessna Aircraft Co. *Wichita, Kansas*	L-19E	Bird Dog	Liaison/Obs. Recon.	2	36	25' 10"	7' 4"	174	1 614	2 400	2 100	1 Con. O-470-11 @ 213 hp.
	T-37B		Trainer	2	33' 10"	29' 3"	9' 2"	183 9	4 056	6 579	6 600	2 Con. J69-T-25 @ 1,025 lb. t.
	U-3B		Administrative	5	35' 9"	29' 7"	9' 11"	149	3 300	4 995	4 990	2 Con. IO-470-D @ 260 hp
General Dynamics Convair *San Diego, Calif*	F-102A	Delta Dagger	AW Interceptor	1	38' 1"	68' 3"	21' 2"					1 P&W J57-P-23 @ 16,000 lb. t
	TF-102A		Trainer	2	38' 1"	68' 2"	20' 7"					1 P&W J57-P-23 @ 16,000 lb. t
	F-106A	Delta Dart	AW Interceptor	1	38' 3"	70' 9"	20' 3"					1 P&W J75 @ 23 500
	T-29C	Flying Classroom	Crew Trainer	4	91' 9"	74' 8"	27' 4"	844	29 500	43 575	43 575	2 P&W R2800-99W @ 2,500 hp
General Dynamics Ft. Worth	B-58	Hustler	Bomber	3	56' 10"	96' 9"	31' 5"	1,542		160 000		4 GE J79 @ 15 000 lb. t
Douglas Aircraft Co. *Santa Monica, Calif*	A3D-2	Skywarrior	Attack	3	72' 6"	74' 5"	22' 9"	812	39 683	70 000		2 P&W J57-P-10 @ 10 500 lb. t
	A4D-2N	Skyhawk	AW Attack	1	27' 6"	40' 1"	15' 2"	260	9 559	16 216		1 Wr J65-W-16A @ 7 700 lb. t
	A4D-5	Skyhawk	Attack	1	27' 6"	41' 4"	15' 2"	260	9 284	15 500		1 P&W J52 @ 8,500 lb. t
Goodyear Aircraft Corp. *Akron, Ohio*	ZPG-2		ASW Airship	14	85' 0"	342' 7"	95' 5"	2 900	40 422	66 800		2 Wr R1300-2A 800 hp. @ 2600
	ZPG-3W		AWE Airship	21	85' 2"	403' 5"	117' 8"	2 842	71 703	93 450	400 000	2 Wr R1820-88 1525 hp. @ 2800
	GA 468	Inflatoplane	Recon. Rescue	1	22'	19' 8"	4'	110	225		550	Nelson 40 bhp. @ 3800 rpm
	GA 466	Inflatoplane	Recon. Rescue	2	28'	15' 3"	7' 10"	84	290		440	McCulloch
Grumman Aircraft Eng'rg Corp. *Bethpage, N. Y.*	F9F-8T	Cougar	Trainer	2	34' 6"	48' 6"	12' 1"			20 600		1 P&W J48-P-8A @ 7 200 lb. t.
	F11F-1	Tiger	Interceptor	1	31' 8"	46' 10"	12' 9"	250	13 428	24 174	24 078	1 Wr J65-W-18 @ 10 500 lb. t
	F11F-1F	Super Tiger	Interceptor	1	31' 8"	46' 10"	12' 8"	250				1 GE J79-3A @ 14 800 lb. t
	S2F-1	Tracker	ASW	4	69' 8"	42' 3"	16' 7"					2 Wr R1820-82 @ 1525 hp
	S2F-3	Tracker	ASW	4	72' 7"	43' 6"	16' 7"					2 Wr R1820-82 @ 1525 hp
	WF-2	Tracer	AEW	4	69' 8"	45' 4"	16' 10"	504				2 Wr R1820 @ 1525 hp.
	W2F-1	Hawkeye	AEW	5	80' 7"	56' 4"	16'				49 500	2 Al T56-A8 @ 4 050 eshp.
	AO-1AF	Mohawk	Observation	2	42	41	12' 8"	330	9 205	14 578	14 075	2 Lyc T53-L-3 @ 1,005 eshp
	A2F-1	Intruder	Attack	2								2 P&W J52 @ 8 500 lb. t.
Helio Aircraft Corp. *Norwood, Mass*	L-28A	Liaison		1	39	30	8' 10"	231	2 037	3 000	3 000	1 Lyc GO-480 @ 295 hp.
Ling-Temco-Vought *Dallas, Texas*	F8U-1	Crusader I	Day Fighter	1	35' 8"	54' 3"	15' 9"					1 P&W J57-P-4A @ 10 200 lb. t
	F8U-1P	Crusader I	Photo-Recon	1	35' 8"	54' 6"	15' 9"					1 P&W J57-P-4A @ 10 200 lb. t
	F8U-2	Crusader II	Day Fighter	1	35' 8"	54' 3"	15' 9"					1 P&W J57-P-16 @ 16 000 lb. t
	F8U-2N	Crusader II	AW Fighter	1	35' 8"	54' 3"	15' 9"					1 P&W J57-P-20 @ 18 000 lb. t
	F8U-2NE	Crusader	AW Fighter	1	35' 8"	54' 6"	15' 9"					1 P&W J57-P-20 @ 18 000 lb. t
Lockheed Aircraft Corp. *Burbank, Calif*	F-104G J	Super Starfighter	Fighter	1	21' 11"	54' 9"	13' 6"					1 GE J79-11A @ 15,600 lb. t.
	F-104F	Super Starfighter	Fighter Trainer	2	21' 11"	54' 9"	13' 6"					1 GE J79-11 @ 15 000 lb. t.
	F-104D	Starfighter	Tac-Trainer	2	21' 11"	54' 9"	13' 6"					1 GE J79-7 @ 15 000 lb. t
	F-104C	Starfighter	Fighter	1	21' 11"	54' 9"	13' 5"					1 GE J79-7 @ 15 000 lb. t
	P2V-7	Neptune	ASW		104' 0"	91' 8"	29' 4"	1 000	49 358	79 935		2 Wr R3350-32W @ 3,250 hp; 2 We J34 @ 3 400 lb. t
	P3V-1	Orion	ASW	10	99	104' 7"	33' 4"	1 300		125 000		4 Al T56-A-10W @ 4 500 shp.
	RC-121D	Warning Star	Radar Picket	31	123' 5"	116' 2"	27	1,654				4 Wr 3350-91 @ 3 250 hp.
	U-2		Research/Recon	1								1 P&W J57 @ 11 200 lb. t.
McDonnell Aircraft Corp. *St. Louis, Mo*	F-101B	Voodoo	Interceptor	2	40		18'					2 P&W J57-P-55 @ 16 000+ lb
	F4H-1	Phantom II	AW Interceptor	2	38' 5"	58						2 GE J79-2 @ 16 150
North American Aviation, Inc. **Columbus (Ohio) Division** *Los Angeles, Calif*	FJ-4B	Fury	Fighter Bomber	1	39' 1"	36' 6"	13' 11"	338		16 000		1 Wr J65-W-16A @ 7 700 lb. t
	A3J-1	Vigilante	AW Attack	2	53'	73'	20					2 GE J79-8 @ 17 000 lb. t.
	T2J-1	Buckeye	Trainer	2	36'	38' 8"	14' 9"	255	5 000	9 010	41 373	1 We J34-48 @ 3 400 lb. t.
	B-70	Valkyrie	Bomber	4							550 000	6 GE J93 @ 30 000 lb. t.
	F-86F	Sabre	Fighter-Bomber	1	37' 1"	37' 6"	14' 7"				14 000	1 GE J47-27 @ 5 970 lb. t.
	F-86H	Sabre	Fighter-Bomber	1	37' 1"	38' 8"	15'					1 GE J73-3 @ 8 920 lb. t.
	F-86K	Sabre	Interceptor	1	37' 1"	40' 4"	15'			15 500	20 347	1 GE J47-33 @ 4 650 lb. t.
	F-86L	Sabre	Interceptor	1	37' 1"	40' 4"	15'					1 GE J47-33 @ 4 580 lb. t.
	F-100C	Super-Sabre	Fighter Bomber	1	38'	47'	15'					1 P&W J57-P-7 @ 10 000 lb. t.
	F-100D	Super-Sabre	Fighter-Bomber	1	38'	47'	16'					1 P&W J57-P-21 @ 10 200 lb. t.
	F-100F	Super-Sabre	Fighter Bomber	2	38'	50'	16'	385 2	21 340	34 235		1 P&W J57 @ 13 450 lb. t
	T-39	Sabreliner	Utility	2	44' 5"	43' 8"	16' 11"	342 5	9 100	15 650		2 P&W J60 @ 3,000 lb. t
	X-15		Research	1	22	50	13'	200			31 275	1 XLR 99RM-1 @ 57 000 lb. t
Northrop Corp. *Hawthorne, Calif*	T-38A	Talon	Trainer	2	25' 3"	44' 2"	12' 10"		4 200		11 500	2 GE J85-5 @ 3 850 lb. t.
	N-156F	Freedom Fighter	Fighter	1	25' 3"	44' 10"	13' 2"	143 4	7 594	12 400	15 230	2 GE J85-5 @ 3 850 lb. t
Republic Aviation Corp. *Farmingdale, N. Y.*	F-105D	Thunderchief	AW Fight. Bomb	1	34' 11"	64' 3"	19' 8"	385	28 000	34 000	45 000	1 P&W J75-P19W @ 26,500 lb
	F-105B	Thunderchief	Fighter Bomber	1	34' 11"	63' 1"	19' 8"	385				1 P&W J75-P5 @ 23,500 lb. t.

	PERFORMANCE						ARMAMENT	CHRONOLOGY				
	Normal fuel cap., gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Stall speed, dirty, mph	Service ceiling, ft.	Combat radius, mi	Number, type and designation	First flight of prototype	First production contract	First deliveries to service	First flight, first production article	Remarks
.	248	238	1,450	84	24,300		None		July 56	Dec 56	Nov 56	
.	153	238	1,463	84	23,800		None	Oct 58	Feb 58	Feb 59	Feb 59	AN/APS-85, AN/APQ-86, JPD-1 radar
p.	210	238	1,500	88	27,000		None	Aug. 59	June 59	Mar 60	Feb 60	
		600+			40,000+	1,500+	2 x 20 mm. cannon, 20,000 lb. bombs	Dec 47	Sept 48	Oct '51	June 50	Production discontinued Feb. 57
		600+			50,000+			Apr 52	Feb 51	June 51	Aug 54	Also J-57-P-29W & J-57-P-19W
t.		600+			50,000+				May 53	Oct 57	Oct 57	Also J-57-P-29W
t		600+			50,000+				Aug 56	June 58	June 58	
t,		600+			50,000+		2 NAA GAM-77 Hound Dog		Sept 57	Oct 58	Oct 58	
t.							4 GAM-87A Skybolts	Mar 61		May 61		
	40	115	1,130	40	20,000	590	None	Dec. 49	June 50	Nov 50	Oct. 50	Reinstated in production for U S Army Feb. 52
	321	408	3,200	85	36,200	308	2 general purpose arm. pods		Sept 58	Nov 55	Nov 59	K14 computing gun sight, recon camera
	133	233	1,080	75	20,000		None	Jan 53	July 57	Dec 57	Nov 57	
		M1+			50,000+		GAR-98 Falcon, 24 x 2.75" rockets	Oct 53				
		M1+			50,000+			Oct 55	Apr 54	Nov 56	Oct 56	Side-by-side seats.
		M2+			50,000+	500	MB-1 Genie, GAR-3, GAR-4	Dec 59				F-106B is tandem two-seater
	1,550	200	1,370	92	24,000		None	Sept. 48				
	15,000	M2+			50,000+		Varied loads in external pods	Nov 56		Nov 56		Delta wing.
	4,385	800+						Oct 52	Feb 51	Mar 56	Sept. 53	Also photo, ECM, tanker and trainer versions
	800	650+					2 x 20 mm. cannon	June 54	Nov. 52	Oct. 55		
	800	580+						June 54	June 60			
rpm								Mar 53		Oct 59	Nov 58	Ruddevator area 152 sq. ft. Used by NASA
rpm	282							July 58		June 59	Dec 59	Ruddevator area 140 sq. ft. Used by NASA
	20	72	550	37	10,300	185		1955		1959	1958	
	18	70	500	43	5,500	150		1957				
		650+					2 x 20 mm cannon					
		M1+					4 x 20 mm. cannon					
		1,000+			55,000		1 x 20 mm. cannon					
							Sonobuoy, depth charges, missiles	Dec 52				
							Sonobuoy, depth charges, missiles	May 59				
											Dec 58	Overhead radome.
												Overhead radome
		316	3,000		25,000	200		Apr 59	June 58	Sept 59	Apr 60	AO-1BF w/ APS-94 SLAR, AO-1CF w/ UAS-4 infrared surveill. equip
												Low-level attack
	60											
		1,100			60,000+		4 x 20 mm. cannon, 32 x 2.75" rockets	Mar 55	June 53	Mar 57	Sept. 58	Plus 2 Sidewinders
		1,100			50,000+			Dec 56		Nov 57	Dec 56	10,000 lb t. w/ aft-burner
		M<2			50,000+		4 x 20 mm. cannon, 32 x 2.75" rockets	Dec 57	Dec 57		Aug. 58	Plus 2-4 Sidewinders
		M<2			50,500+		4 x 20 mm cannon, 4 Sidewinders		Oct 58	June 60	Feb 60	
		M<2			50,000+		4 x 20 mm cannon, 4 Sidewinders	June 61				
		M2+			70,000+		1 x T-171 Vulcan, 2 x Sidewinders	Mar 54	Mar 56	Oct. 58	Sept. 58	Being built in Europe, Canada & Japan
		M2+			70,000+		1 x T-171 Vulcan, 2 x Sidewinders		Mar 59	Dec 59	Jan 59	
		M2+			70,000+		1 x T-171 Vulcan					
		M2+			70,000+		1 x T-171 Vulcan, 2 x Sidewinders			Oct 58		
alen		345			23,000+		5 x 20 mm. cannon	May 46	Apr 52	Apr 54	Apr 54	
							Torpedoes, depth charges, bombs	Nov 59		July 51	Apr 61	Rockets
		450+										
		300					None			Dec 53		WV-2 Navy version
			2 5,000		75,000+		None					Recon
t.		1,000+					GAR-98 Falcon, 2 MB-1 Genie					
		M2+				1,500	4 Sparrow III, Sidewinders	May 58				USAF F-110, RF-110
		987	7,500	115	40,000+		4 x 20 mm. cannon, Sidewinders					Rearward bomb ejection
		M2									Aug 58	Boundary layer control.
	381	402	5,000	70	40,000		2 x 50 cal. mg. 14 x 2.75" rockets	Jan 56	Sept 56	July 59	Jan 58	
		M<3			70,000+	7,000						
		650+			45,000+	500	6 x .50 cal. mg. 16 x 5" HVAR	Apr 53	Dec 57		Sept 53	
		700			45,000+	1,150	4 x 20 mm. cannon	July 54				NATO
		650+			45,000+	500+	4 x 20 mm. cannon					Many F-86D conversions.
		550+			45,000+			May 53	Mid-53	Sept 54		
		1,000			53,000+	500+	4 x 20mm. cannon	Jan 56		Mid 55		
		1,000			50,000+	1,500+	4 x 20 mm. cannon	Aug 59	May 56	Mar 57	Mar 57	Also Fighter-Trainer
	1,185	1,000	20,000		50,000+	1,000+	2 x 20 mm. cannon	Sept 56				To NASA for high speed research
		M 6					None	Sept. 58	Oct 58			TBJ
	650	575		87	40,000+	1,400	None	Jan 27	Jan 59	Oct 59	June 60	Transferred to NASA
		M1.2+			58,000			Apr 58	Dec 56		Jan 60	
		M2+			52,200			July 59				
t.		M2+			50,000+		Vulcan 20 mm., Sidewinder, Bullpup	Oct. 55			June 59	Ext. navigation radar, fire control system.
		M2			50,000		Vulcan 20 mm., Sidewinder, Bullpup	Oct 55			Apr 58	

U. S. Missiles

	GENERAL				STATUS				AIRFRAME				
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service use	Manufacturer	Over-all length less booster ft.	Over-all span wings or fins ft.	Body diameter, ft.	Launching weight less booster lb.
Air-to-Air	Falcon	GAR-1, 2, 3, 4, 9, 11	USAF	Hughes			√	√	Hughes	6.5	1.8	0.5	100
	Genie	MB-1	USAF	Douglas			√	√	Douglas	9			800
	Mighty Mouse		Navy	BuWeps			√	√		1		0.23	20
	Sidewinder 1A	AAM-N-7	Navy	BuWeps			√	√		9		0.4	155
	Sidewinder 1C		Navy	Philco		√	√						
	Sparrow III	AAM-N-6	Navy	Raytheon		√	√	√	Raytheon	12	3.3	0.7	400
Air-to-Surface	Bullpup	ASM-N-7A, GAM-83A	Navy, USAF	Martin-Marietta, Maxson			√	√	Martin-Marietta, Maxson	11	1	1	571
	Bullpup B	ASM-N-7B	Navy	Martin-Marietta		√			Martin-Marietta	11.6			1,750
	Nuclear Bullpup	GAM-83B	USAF	Martin-Marietta		√			Martin-Marietta				
	Hound Dog	GAM-77A	USAF	NAA			√	√	NAA	42.5		2.3	10,000
	Quail	GAM-72	USAF	McDonnell			√	√	McDonnell	10	7	1.5	1,100
	Shrike		Navy	Texas Instruments									
	Skybolt	GAM-87A	USAF	Douglas	√	√			Douglas	38.5			9,000
	Zuni		Navy	BuWeps			√	√	Naval Prop. Plant	9.17		0.1	10
Underwater	Able-Alfa	SUM	Navy	Avco			√	√		8.5		1.1	500
	Asroc	RUR-5A	Navy	Minn. Honeywell			√	√	Minn. H. Gen. Mills	15	2.5	1	1,000
	Astor	SUM	Navy	Westinghouse	√	√				20			
	Subroc	SUM	Navy	Goodyear Aircraft		√			Goodyear Aircraft				
Surface-to-Air	Bomarc	IM-99A	USAF	Boeing		√	√	√	Boeing	47	18.2	1	16,000
	Bomarc	IM-99B	USAF	Boeing		√	√	√	Boeing	47	18.2	3	16,000
	Hawk	XM-3	Army	Raytheon		√	√	√	Northrop, Raytheon	17	4	1.2	1,250
	Mauler		Army	GD/Pomona	√	√			GD/Pomona				
	Nike Ajax	SAM-A-7	Army	Western Electric				√	Douglas	21		1	2,500
	Nike Hercules	SAM-A-25	Army	Western Electric			√	√	Douglas	27		2.5	10,000
	Nike Zeus		Army	Western Electric	√	√			Douglas	48.3			
	Redeye		Army, Mar.	GD/Pomona, Ameco	√	√				4		0.25	2
	Talos	SAM-N-6	Navy	Bendix			√		McDonnell	28		2.5	3,000
	Tartar		Navy	GD/Pomona		√	√		GD/Pomona	15		1.5	1,500
	Terrier	SAM-N-7	Navy	GD/Pomona			√	√	GD/Pomona	15		1.5	3,000
	Typhon		Navy	Bendix		√			McDonnell				
Surface-to-Surface Long Range	Atlas	SSM-65	USAF	GD/Astronautics		√	√	√	GD/Convair	82+	16	10	260,000
	Crossbow		USAF		√								
	Slam		USAF	Chance Vought	√								
	Jupiter	SSM-78	Army, USAF	Chrysler				√	Chrysler	60		9	110,000
	Mace	TM-76	USAF	Martin-Marietta			√	√	Martin-Marietta	44	22.9	4.5	14,000
	Minuteman	WS-133A	USAF	Boeing			√		Beech, Boeing	57		5.5	65,000
	Polaris	FBM	Navy	Lockheed			√	√	Lockheed	28			28,000
	Thor	SM-75	USAF	Douglas			√	√	Douglas	62		8	110,000
	Titan I	SM-68	USAF	Martin-Marietta	√	√	√		Martin-Marietta	98		10	220,000
	Titan II	SM-68B	USAF	Martin-Marietta	√	√	√		Martin-Marietta	102		10	300,000
Battlefield Support	Corporal	SSM-A-17	Army	Firestone, Gilfillan			√	√	Firestone	46		2.5	12,000
	Honest John*	XM-50	Army	Emerson Elec.			√	√	Emerson Elec.	25	4.5	2	
	Lacrosse	SSM-A-12	Army	Martin-Marietta				√	Martin	19.2	9	1.7	2,300
	Little John	XM-51	Army	AOMC			√	√	Emerson Elec.	15	2	1	
	Pershing		Army	Martin-Marietta	√	√	√		Martin-Marietta	34		3.4	10,000
	Redstone	SSM-A-14	Army	Chrysler				√	Chrysler	69		6	61,000
	Sergeant		Army	Sperry		√	√		Sperry	34	6	3	10,000
	Shillelagh		Army	Aeronutronic		√							

ABBREVIATIONS:
AOMC — Army Ordnance Missile Command
AC — AC Spark Plug
ATRAN — Automatic Terrain Recognition
BuWeps — Bureau of Weapons
Em. Elec. — Emerson Electric
GD — General Dynamics
GE — General Electric
GFE — Government Furnished Equipment
HPC — Hercules Powder Company

POWERPLANT				GUIDANCE		PERFORMANCE		REMARKS
Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum mach. number	Maximum range No. of mi	
Thiokol	1	spr		Hughes	Semi active homing infrared			GAR 1 & 3 use radar 2 & 4 infrared. GAR-9 will have longer range and nuclear capability
Aerojet General	1	spr			Unguided		1.5	Nuclear warhead, completing test program
Naval Prop. Plant	1	spr			Unguided			Folding fin aircraft rocket.
Naval Prop. Plant	1	spr		Philco G.E	Infrared		2	Developed by NOTS used by USAF and NATO.
					Infrared			Under dev at NOTS. More speed & range
Aerojet General	1	spr		Raytheon	Semi-active radar homing	3+		All weather all aspect capability
Thiokol	1	lpr		Maxson	Command	1.8	3+	Storable Propellant
Thiokol	1	lpr		Martin Marietta				
P&W	1	J52 tj	7,500	Autonetics	Inertial	1+	500+	For B-52G. Penetration
G.E.	1	J85 tj	2,500		Gyro autopilot	0.9	200	Diversionary decoy
Aerojet General	2	spr		Texas Instruments Northrop	Inertial star tracking		1,000	GE ablation nose cone air-launch ballistic missile.
Naval Prop. Plant	1	spr			Unguided	2+	5+	Folding fin all weather rocket
Naval Prop. Plant	1	spr					var	Fired from gun launchers.
Naval Prop. Plant	1	spr			Unguided			Comb. missile torpedo and depth charge.
Thiokol	1	spr		Kearfott Hill concept				Fired through torpedo tubes.
Marquardt	2	RJ43 MA-3	10,000	Westinghouse	SAGE active radar homing	2+	250	Aerojet Gen. liq. prop. booster
Marquardt	2	RJ43 MA-11		Kearfott Westinghouse	SAGE active radar homing	2+	400	Thiokol solid prop booster
Aerojet General HPC	1	XM22E8 spr		Raytheon	Semi-active radar homing		22	FW at low & int. alt. Mobile or fixed site.
HPC		spr		Raytheon-Burroughs	Radar			Self-contained mobile weapon
Aerojet General	1	lpr	2,500	Western Electric	Command		25	Spr booster by Hercules.
Thiokol	1	spr		Western Electric	Command		75+	14.5 ft. Ajax spr boosters.
Thiokol	3	spr	400,000	Western Electric	Command			
				Philco GD Pomona	Infrared			Shoulder fired bazooka type air defense.
McDonnell HPC	1	rj		Sperry	Beam rider/semi-active homing	2+	65+	Also surface-to-surface spr booster
Aerojet General	1	spr		Raytheon		1+	10	Dual thrust motor
Atlantic Research HPC	1	spr		Sperry	Beam rider	2.5	10	Imp. version inc. range to 20 miles.
McDonnell				Westinghouse			200	
NAA Rocketdyne	3	MA-2 lpr	389,000	GE-Burroughs Arma	Radio command inertial	20	8,000+	Two 165,000 lb. MA-3, one 57,000 lb. sustainer. [illegible] operational.
		rj					5,500	Class and Slam are proposed chemical and nuclear low altitude missiles.
Marquardt	1	Nuclear rj			Command inertial	1+	5,500	
NAA Rocketdyne	1	530 lpr	150,000	Ford Instrument	Inertial		1,500	Developed by Army. Used by NATO
Allison	1	114-A 41 tj	5,200	Goodyear AC	Atran-Inertial	0.9	1,200	Improved mace for spr booster
Thiokol Aerojet HPC	3	spr	290,000	NAA Autonetics	Inertial	20	5,500	Avco Mk. 5 nose cone.
Aerojet Gen HPC	2	spr		GE Honeywell Hughes	Inertial			Guidance developed by MIT produced by Sperry/Autonetics.
NAA Rocketdyne	1	MB-3 lpr	150,000	AC	Inertial	13	1,500	GE Mk. 2 heat sink nose cone
Aerojet Gen	3	lpr	380,000	Western Electric-Sperry Rand	Radar Command inertial	23	9,000	Avco Mk. 4 nose cone.
Aerojet Gen	3	lpr	430,000	AC-IBM	Inertial		6,300+	GE Mk. 6 ablation nose cone storable fuel.
Ryan	1	lpr	20,000	Gilfillan	Command	3	75	Nuclear all-weather; deployed in Europe.
HPC Eng. Electric	1	XM33E3			Unguided			Improved range and accuracy
Thiokol	1	M-IPE1 spr		Martin	Command		20	GE arming and fusing.
HPC	1	XM20E1 spr			Unguided			GE arming and fusing.
Thiokol	2	spr		Bendix	Inertial			Select v. range artillery missile
NAA Rocketdyne	1	A-7 lpr	75,000	Ford Instrument	Inertial		200	Deployed in Europe.
Thiokol	1	spr		Sperry	Inertial		85	Air transportable. Corporal replacement. With training units.
	1				Inertial			

IRBM — Intermediate Range Ballistic Missile
LPR — Liquid Propellant Rocket
MIT — Massachusetts Institute of Technology
NOTS — Naval Ordnance Test Station
rj — ram jet
spr — solid propellant rocket
tj — turbojet
† — Gross takeoff weight
*Improved

U. S.—U.S.S.R. Spacecraft

Category	Spacecraft	Agency	Maximum Weight (lbs) Approx.[1]	First Launch[2]	Orbit (Mi.)
MANNED VEHICLES	Mercury	NASA	2,900	Feb. 62	120
	Gemini	NASA	7,000	3rd qtr. 63	300
	Agena B Gemini Target	NASA	9,900	3rd qtr. 63	300
	Apollo A	NASA NASA	28,000 35,000	1964 1964	300
	Apollo B	NASA NASA	45,000 91,000	1966 1966	
	Apollo C	NASA	210,000	1967	
	Dyna Soar	USAF	15,000	1965	300
	Vostok	USSR	10,434	4/12/61	130
APPLICATIONS SATELLITES	Tiros	NASA	285	4/1/60	400
	Nimbus	NASA	600	4th qtr. 62	500
	Aeros	NASA			Synch
	Echo	NASA	199	8/12/60	1,000
	Echo 2	NASA	550	2nd qtr. 62	650
	Relay		125	3rd qtr. 62	3,000-500
	Rebound			4th qtr. 63	1,500
	Syncom		85	3rd qtr. 63	synch
	Telstar	Commercial	170	3rd qtr. 62	3,000-500
	Advent	Army	500	1962	synch
	Transit	Navy	175	4/13/60	480-230
	Courier	Army	165	10/4/60	650
LUNAR-PLANETARY	Ranger 1	NASA	670	8/23/61	
	Ranger 2	NASA	727	1/26/62	
	Surveyor A	NASA	2,500	1964	
	Surveyor B	NASA	2,500	1965	
	Mariner A	NASA	450	3rd qtr. 62	
	Mariner B	NASA	1,300	1965	
	Prospector	NASA	2,500		
	Lunik	USSR	3,245	1/2/59	
	Venus Probe	USSR	1,410	2/12/61	
SCIENTIFIC SATELLITES	Discoverer Series	USAF	2,450	2/28/59	100
	Pioneer Series		94.8	10/11/58	Varies
	Explorer Series		143.0	1/31/58	Varies
	Sputnik Series	USSR	14,292	10/4/57	Varies
	Orbiting Solar Observatory	NASA	440	1st qtr. 62	300
	Orbiting Geophysical Observatory	NASA	500	1st qtr. 63	Varies
	Orbiting Astronomical Observatory	NASA	3,300	4th qtr. 63	470
	Micrometeor Hazard	NASA	135	2nd qtr. 62	400
	Energetic Particles	NASA	83	2nd qtr. 62	400
MILITARY SATELLITES	Samos	USAF	4,100	1/31/61	300
	Midas	USAF	5,000	5/24/60	300
	Saint	USAF	3,500	1962	500
	Bambi	USAF		1964	
PROBES	Nerv		83	10/19/60	
	Bios		58		
	Fire			1st qtr. 63	
	Trailblazer		45		
	Sert		200	3rd qtr. 62	4,100
	Electron Density		94	1st qtr. 62	4,200

[1] Weight in orbit. Apollo weights include 10,500-lb. re-entry vehicle (command module) and are based on use of liquids and solids for the propulsion mod
[2] Date first successful launch accomplished.

Launch Vehicle	Objective
Atlas D	3-orbit manned mission, followed by 18-orbit mission in modified capsule.
Titan 2	Rendezvous development. 14-day mission by 2 men. Test Apollo components.
Atlas D	Target for 2-man Gemini chaser.
Saturn C-1	14-day earth orbit in 3-man spacecraft. 6-man mission for approx. 7 days. Weight with laboratory.
Saturn C-5	Circumlunar flight in 3-man spacecraft. Lunar orbit.
Saturn C-5	Lunar landing and exploration in 3-man spacecraft.
Titan 3	Reconnaissance, bombing orbital glider.
	Earth orbit.
Delta	Obtain baseline data on clouds, IR, and test components for operational weather satellites.
Thor Agena B	Basis for operational weather satellite.
Centaur	24-hour synchronously orbiting weather satellite.
	Passive communications satellite development using 100-ft. inflatable sphere.
Thor Agena B	Passive communications satellite with rigidized inflatable sphere 135-ft. in diameter.
Delay	Development of lightweight active communications repeater satellite at low altitudes.
Atlas-Agena B	Launch of three 135 ft. diameter rigid inflatable spheres for passive communications.
Delta	Two-way transmission with lightweight active repeater in a synchronous orbit.
Delta	AT&T funded project to develop wide band commercial communications satellite.
Centaur	Synchronously orbiting active communications repeater, early launches will use Atlas-Agena vehicle.
Thor Ablestar	Navigation beacon development.
Thor Ablestar	Low orbit active repeater communications satellite.
Atlas-Agena B	Component test vehicle (two launches).
Atlas-Agena B	Hard lunar impacter.
Centaur	Soft lunar impacter.
Centaur	Precise lunar orbit.
Atlas-Agena B	Venus flyby.
Centaur	Venus flyby/Mars flyby.
Saturn C-1	Soft lunar impact, land supplies for manned exploration of moon.
	Lunar probe, impact 9/13/59.
	Venus flyby (Sputnik 8).
Thor-Agena B	Test designs, techniques and components for military and scientific satellites.
Juno, Jupiter	Drag probes, solar satellites.
Delta, Scout	Scientific earth satellites.
	Soviet satellites.
Delta	Study electromagnetic radiation from the sun.
Atlas-Thor-Agena B	Study radiation belt, ionosphere phenomena, magnetic fields.
Atlas-Agena B	Make stellar observations in the UV spectrum with orbiting telescope.
Scout	Analysis of puncture hazards on spacecraft.
Delta	Study radiation belt.
Atlas-Agena B	Photo reconnaissance.
Atlas-Agena B	Detect ICBMs through infrared.
Atlas Agena B	Inspection of ground launched ICBM.
Atlas Agena B	Anti-ICBM satellite.
Argo D-8	Study radiation hazards on biological specimens.
Argo D-8	Advanced Nerv.
Atlas Antares	Re-entry at 37,000 fps.
	Continuing NASA-ARPA-MIT study of re-entry physics.
Scout	Flight test ram and ramjet engines.
Scout	Study concentrations and radio wave propagation.

...ule. Use of storable propellants would reduce overall weight by 10-15%.

• SPECIFICATIONS

MA-6 ATOP ATLAS 109D

U.S. Launch Vehicles

Vehicle Name	User Agency	Vehicle Contractor	Propulsion: Stage	Propulsion: Quantity	Propulsion: Contractor	Stage Contractor	Stage Designation	Propellant
Nova	NASA		1 2 3	8 4 1	Rocketdyne F-1 Aerojet M-1 Rocketdyne J-2	 Douglas	N-1 N-2 N-3	LOX/RP LOX/H_2 LOX/H_2
Saturn C-5	NASA		1 2 3	5 5 1	Rocketdyne F-1 Rocketdyne J-2 Rocketdyne J-2	Boeing NAA Douglas	S-1B S-2 S-4B	LOX/RP LOX/H_2 LOX/H
Saturn C-1	NASA		1 2 3	8 6 2	Rocketdyne H-1 P&W RL-10-A3 P&W RL-10-A3	Chrysler Douglas GD/Astronautics	S-1 S-4 S-5	LOX/RP LOX/H LOX/H_2
Centaur	NASA/Army	GD/Astronautics	1 2	1 2	Rocketdyne MA-2 P&W RL-10-A3	GD/Astronautics GD/Astronautics	Atlas D Centaur	LOX/RP LOX/H
Thor Ablestar	USAF/Navy	Douglas	1 2	1 1	Rocketdyne DM-21 Aerojet AJ-10-104	Douglas Aerojet	Thor Ablestar	LOX/RP IRFNA/UDMH
Atlas Agena B	USAF/NASA	GD/Astronautics	1 2	1 1	Rocketdyne MA-2 Bell 8096	GD/Astronautics Lockheed	Atlas D Agena B	LOX/RP IRFNA/UDMH
Atlas	USAF/NASA	GD/Astronautics	1	1	Rocketdyne MA-2	GD/Astronautics	Atlas D	LOX/RP
Thor Agena B	USAF/NASA	Douglas	1 2	1 1	Rocketdyne DM-21 Bell 8096	Douglas Lockheed	Thor Agena B	LOX/RP IRFNA/UDMH
Thor Delta	NASA	Douglas	1 2 3	1 1 1	Rocketdyne DM-21 Aerojet AJ-10-118 ABL-248	Douglas Douglas Douglas	Thor Altair	LOX/RP IWFNA/UDMH Solid
Scout (XRM 90)	NASA	Chance Vought	1 1a 2 3 3a 4 4a 5	1 1 1 1 1 1 1 1	Aerojet XM-68 Aerojet Thiokol XM-33-28 ABL X254 A1 ABL X259 ABL X248 ABL X258 NOTS 100A (spherical)		Algol Algol-2 Castor Antares Antares 2 Altair Altair 2 Cetus	Solid Solid Solid Solid Solid Solid Solid Solid
Blue Scout 1 (XRM 89)	USAF	Ford Aeronutronic	1 2 3	1 1 1	Aerojet XM68 Thiokol XM75 ABL X254 A2		Algol Castor Antares	Solid Solid Solid
Blue Scout 2 (XRM 90)	USAF	Ford Aeronutronic	1 2 3 4	1 1 1 1	Aerojet XM68 Thiokol XM75 ABL X254 A2 ABL X248-A5		Algol Castor Antares Altair	Solid Solid Solid Solid
Blue Scout Jr (XRM 91)	USAF	Ford Aeronutronic	1 2 3 4	1 1 1 1	Thiokol XM-33 ABL X254-A1 Aerojet AJ10-41 NOTS 100 A		Castor Antares Alcor Cetus	Solid Solid Solid Solid
Ram	NASA		1 2 3	1 1 1	Aerojet ABL X254-A1 Aerojet AJ10-41		Aerojet Jr Antares Alcor	Solid Solid Solid
Titan 2	USAF/NASA	Martin	1 2	1 1	Aerojet XLR87-AJ5 Aerojet XLR91-AJ5			N_2O_4/Hydrazine—UDMH N_2O_4/Hydrazine—UDMH
Titan 2 (with upper stage)	USAF	Martin						
Titan 3	USAF		1 2 3	1 1	Aerojet XLR87 AJ5 Aerojet XLR91 AJ5 (2 120" solids)			
Titan 3 (with upper stage)	USAF							

Contractors

Rocketdyne — Rocketdyne Division of North American Aviation, Inc.
Aerojet — Aerojet General Corp.
P&W — Pratt & Whitney Division of United Aircraft Corp.
Bell — Bell Aerosystems Co., Division of Bell Aerospace Corp.
ABL — Hercules-Allegheny Ballistics Laboratory
NOTS — Naval Ordnance Test Station
GD/Astronautics — General Dynamics/Astronautics

Nominal Thrust (lb.)	Diameter (ft.)	Height (ft.)	Pad Weight (lb.)	Performance: Orbital Weight (lb.)	Performance: Escape Weight (lb.)	Remarks
12 million 4.6 million 200,000	80	280	9.6 million	375,000	150,000	Direct ascent vehicle for manned lunar flight to earth rendezvous does not prove feasible launcher for flights beyond the moon, some Novas may eventually use solid-propellant first stage.
7.6 million 1 million 100,000	33	270	6 million	220,000	90,000	Main vehicle for circumlunar and lunar landing flights with Apollo three-man spacecraft; depends on development of rendezvous-in-orbit technique; four launch pads planned in expanded portion of Air Force Missile Test Center.
1.6 million 90,000 20,000	21.6	125 (162)	1.6 million	10,000	5,000	Main vehicle for development flights of Apollo spacecraft, including manned earth orbit flights of Apollo.
887,000 30,000	10	105	291,000	6,000	2,300	First launch vehicle to use liquid hydrogen-fueled upper stage; will pioneer liquid hydrogen technology for Saturn and Nova upper stages; launch later lunar and planetary probes and Advent communications.
165,000 7,870	6	77.5	112,000	7,000		Developed from USAF Thor Able series, using upper stage developed from Navy Vanguard vehicle. first upper stage to incorporate re-start capability used for launching of Navy Transit navigation satellites
387,000 16,000	10	95	276,000	5,000	700	Developed for USAF Midas and Samos programs; used by NASA for Ranger lunar vehicle series and other space shots; restartable upper stage; most powerful space launch vehicle currently in use by U.S.
607,000	10	72	230,000	2,700		First U.S. ICBM; used as booster for orbital Mercury manned capsule flights and as booster for Atlas-Able series (discontinued) and Atlas Agena vehicles; most powerful booster currently in space use.
165,000 16,000	8	80	123,000	1,000		Workhorse vehicles in USAF Discoverer research and development flights; planned for NASA use from Pacific Missile Range.
108,000 7,700 2,800	8	62	112,000	900		Developed from USAF Thor Able series, using Vanguard upper stages; has launched experimental Echo passive communications satellites and NASA scientific satellites and probes.
120,000 100,000 65,000 13,000 10,000 3,100 6,000 900	10	65	36,000	100		Basic NASA booster for near-earth space sounding probes; some satellite work; originally composed of off-the-shelf solid propellant motors but modified motors now are being developed for some stages.
120,000 80,000 13,000	3.3	72	83,987	100 lb. probe—1,610 mi.		Basic USAF booster for near-earth space sounding probes, aerodynamic research work; developed in conjunction with NASA Scout program
120,000 65,000 13,000 3,100	3.3	72	85,588	100 lb. probe—2,300 mi.		
85,000 15,000 8,000 900	2.0	31	16,300	100 lb. probe—4,550 mi.		
57,000 12,000 6,000	2.55			Under study		Proposed extension of Scout booster
430,000 100,000	10	80	600,000	6,000		Space version of Titan 2 missile will boost two-man Gemini capsule for NASA
—	30	90	—	20,000	8,000	Space booster for use with upper stages, including standardized Agena D
3.2 million						Titan 2 vehicle with two 100 in.-dia. segmented solid propellant boosters strapped to sides. Expected to be booster for USAF Dyna-Soar orbital glider, other space payloads.
						Same as above but with upper stages added; these will include the standardized Agena D, possibly Centaur

Propellants
LOX SP — Liquid Oxygen-Kerosene
LOX H_2 — Liquid Oxygen-Liquid Hydrogen
IRFNA/UDMH — Inhibited Red Fuming Nitric Acid — Unsymmetrical Dimethyl Hydrazine
IWFNA/UDMH — Inhibited White Fuming Nitric Acid — Unsymmetrical Dimethyl Hydrazine
N_2O_4 — Nitrogen Tetroxide

Space Vehicle Log

(As of Feb 1 1962)

Satellites In Orbit[1]	Name	Launch	Period (Min.)	Apogee (Stat. Mi.)	Perigee	Transmitting Freq. (Mc.)[2]	Weight in Orbit[3] (Lb.)
1958 Alpha 1	Explorer 1	1 Feb. 58	105.9	1,060	239		30.8
1958 Beta 2	Vanguard 1	17 Mar. 58	133.8	2,447	403	108.022	56.3
1959 Alpha 1	Vanguard 2	17 Feb. 58	125.3	2,087	305		21.5
1959 Eta 1	Vanguard 3	18 Sept. 59	129.8	2,298	338		100
1959 Mu (USSR)	Lunik 1	2 Jan. 59	450 Days	1.3177AU	0.9764AU		3,245
1959 Nu	Pioneer 4	3 Mar. 59	398 Days	1.1421AU	0.9871AU		13.4
1959 Iota 1	Explorer 7	13 Oct. 59	101.1	669	344		91.5
1960 Alpha	Pioneer 5	11 Mar. 60	311.6 Days	0.9951AU	0.8061AU		94.8
1960 Beta 2	Tiros 1	1 Apr. 60	99.1	467	429	107.997	270
1960 Gamma 2	Transit 1B	13 Apr. 60	94.7	400	229		265
1960 Epsilon 1 (USSR)	Sputnik 4	15 May 60	91.4	266	160		10,008
1960 Zeta 1	Midas 2	24 May 60	94.2	310	299		5,000
1960 Eta 1	Transit 2A	22 Jun. 60	101.6	649	389	162, 216	223
1960 Eta 2	Grab	22 Jun. 60	101.6	655	382		42
1960 Iota 1	Echo 1	12 Aug. 60	116.2	1,222	658		240
1960 Nu 1	Courier 1B	4 Oct. 60	106.9	750	604	107.9709	500
1960 Xi 1	Explorer 8	3 Nov. 60	112.4	1,409	258		90.14
1960 Pi 1	Tiros 2	23 Nov. 60	98.2	461	378		280
1961 Alpha 1	Samos 2	31 Jan. 61	94.9	339	295		4,100
1961 Gamma 1 (USSR)	Venus Probe	12 Feb. 61	300 Days	1.019AU	0.7163AU		1,419
1961 Delta 1	Explorer 9	16 Feb. 61	118.1	1,522	466		80
1961 Epsilon 1	Discoverer 20	17 Feb. 61	92.8	339	167		2,450
1961 Zeta 1	Discoverer 21	18 Feb. 61	92.6	348	146		
1961 Kappa 1	Explorer 10	25 Mar. 61	Position Uncertain				79
1961 Lambda 1	Discoverer 23	8 Apr. 61	91.6	267	166		2,100
1961 Nu 1	Explorer 11	27 Apr. 61	107.0	1,108	303		82
1961 Omicron 1	Transit 4A	29 Jun. 61	103.8	628	547	54; 150, 324; 400	175
1961 Omicron 2	Injun-Grab	29 Jun. 61	103.8	619	548	136.5	95
1961 Rho 1	Tiros 3	12 Jul. 61	100.3	518	457	108, 108.03	285
1961 Sigma 1	Midas 3	12 Jul. 61	161.5	2,288	2,078		3,500
1961 Upsilon 1	Explorer 12	16 Aug. 61	1,587.3	47,627	481		83
1961 Alpha Delta 1	Midas 4	21 Oct. 61	172				3,500
1961 Alpha Epsilon 1	Discoverer 34	5 Nov. 61	96.2	571	140		2,100
1961 Alpha Eta 1	Transit 4B	15 Nov. 61	105.6	689	593	136.8, 54, 324, 150, 400	200
1961 Alpha Eta 2	TOAC	15 Nov. 61	105.6	694	589	136.65, 54, 324	200
1961 Alpha Kappa 1	Discoverer 36	12 Dec. 61	90.9	252	135		2,100
1961 Alpha Kappa 2	Oscar	12 Dec. 61	88.2	112	112		10
1962 Alpha 1	Ranger 3	26 Jan. 62	406.4 Days	1.1935	0.9839AU		727

Decayed Satellites[3]

Designation	Name	Launch	Decay	Weight in Orbit (Lb.)
1961 Alpha Beta	Discoverer 31	17 Sept. 61	26 Oct. 61	1,800
1961 Alpha Gamma 1	Capsule (Discoverer 32)	13 Oct. 61	14 Oct. 61[4]	300
1961 Alpha Gamma	Discoverer 32	13 Oct. 61	13 Nov. 61	1,800
1961 Alpha Zeta 1	Capsule (Discoverer 35)	15 Nov. 61	16 Nov. 61	300
1961 Alpha Theta 1	Ranger 2	18 Nov. 61	20 Nov. 61	675
1959 Delta 1	Explorer 6	7 Aug. 59	Before Jul. 61	142
1961 Alpha Iota 1	Mercury-Atlas 5	29 Nov. 61	29 Nov. 61[4]	2,700
1961 Alpha Kappa 1	Capsule (Discoverer 36)	12 Dec. 61	12 Dec. 61[4]	300
1961 Alpha Zeta 1	Discoverer 35	15 Nov. 61	3 Dec. 61	1,800

Notes: [1] Orbital elements of solar satellites given in Astronomical Units, approximately 93 million mi. [2] Frequencies given only for satellites still transmitting. [3] Satellites decayed since last Space Vehicle Log published Nov. 27, p. 77. [4] Successful re-entry and recovery. U.S. has launched all satellites except those noted USSR.

Sources: National Aeronautics and Space Administration Operations Control Center, North American Air Defense Command (Norad), and Smithsonian Astrophysical Observatory (SAO).

U.S. Sounding Rockets

Manufacturer	Name	Agency	Overall length, ft.	Diameter	Launching weight, lbs.	Powerplant (Stage Manufacturer Engine designation Rated thrust)	Remarks
[illegible]	Aerobee 100	NASA USAF	25 75	1 25	1 100	1st Aerojet AJ10-102 lpr @ 2,600 lb. t.	Tower launched. Uses Aerojet 2.5KS-18,000 lb. t booster–5 lbs.
	Aerobee 150	Navy USAF	30	1 25	1 000	1st Aerojet AJ11-21 lpr @ 4 100 lb. t.	Corrosive acid propellant makes immediate launch necessary
	Aerobee 150A	NASA	26 75	1 25	1 000	1st Aerojet AJ60-13 lpr @ 4 100 lb. t.	Uses Aerojet 2.5KS 18,000 lb. t booster 4 fins
	Aerobee 300	USAF	32 5	1 25	2 000	1st—Aerojet AJ60-13 lpr @ 4 100 lb. t. 2nd—Douglas Sparrow 1 8KS apr @ 7,800 lb. t	Similar to Aerobee 150 or 150A
	Aerobee 300A	NASA	31 3	1 25	2 200	1st Aerojet AJ60-13 lpr @ 4 100 lb. t. 2nd—Douglas Sparrow 1 8KS apr @ 7 800 lb. t.	
[illegible]	Argo F-3	USAF	57	2	7 300	1st—HPC ABL M6 @ 86,000 lb. t 2nd HPC ABL M5 @ 48,700 lb. t. 3rd HPC ABL M5 @ 48,700 lb. t 4th—Thiokol TX 77 30 12 150 lb. t 5th—Thiokol T-55 @ 1 650 lb. t	Jason 50 lb. payload to 500 n mi
	Argo D-4	NASA USAF	48	2	7 300	1st—HPC ABL M6 @ 86,000 lb. t 2nd—HPC ABL M5 @ 48,700 lb. t. 3rd—HPC ABL M5 @ 48,700 lb. t. 4th—HPC ABL X-248 @ 1 150 lb. t	Javelin 1000 lb. payload to 500 n mi / Altair
	Argo D-8	NASA	62	3 5	14 000	1st Thiokol XM 20 TX 77 2 @ 140,000 lb. t 2nd GCR Lance @ 47,000 lb. t 3rd—GCR Lance @ 47 000 lb. t. 4th—HPC ABL X-248 @ 1,150 lb. t.	Journeyman 100 lb. payload to 1000 n mi.
	Argo A 1	NASA	21	2 6	10 000	1st—Thiokol TX-33 TX 77-2 @ 100 000 lb. t	Percheron 1st stage in Shotput
	Argo B-1	NASA USAF	24	1 11	1 540	1st—HPC ABL M5 @ 48,700 lb. t. 2nd—Thiokol Cajun @ 8 000 lb. t	40 lb. payload to 150 n mi
[illegible] Research [illegible] Va	Arcas	NASA USAF/Army/Navy	9 9	0 4	77	1st—Atlantic 29KS 350 @ 350 lb. t.	Carried 5-20 lb. payload to 60 mi altitude.
	Arcas Robin	USAF	0 7	4 5	73	1st—Atlantic 60KS 350 @ 350 lb. t.	5 lb. payload to 90 mi. altitude.
	Boosted Arcas	Army USAF	12	4 5	100	1st—Atlantic 1KS 2 200 @ 2,200 lb. t 2nd—Atlantic 29KS 336 @ 336 lb. t	12 lb. payload to 68.8 mi. altitude.
	Archer	NASA USAF/Navy	12 8	0 50	294	1st Atlantic 15KS 1,375 @ 1,375 lb. t.	40 lb. payload to 90 mi altitude.
	Iris	NASA USAF	10 8	1 0	1 212	1st—Atlantic 52KS 4,570 @ 4 575 lb. t.	75 lb. payload to 200 mi altitude.
	Metroc I	NASA Army Navy	4 45	0 23	10 8	1st—Atlantic 10KS 140 @ 140 lb. t.	2 lb. payload to 15 mi. altitude.
	Metroc II	NASA USAF Army Navy	8	0 3	80	1st Atlantic 10KS 140 @ 140 lb. t. 2nd	4 lb. payload to 64 mi altitude.
	Nike Archer	NASA USAF Navy	25	1 1	1 350	1st HPC ABL M5 @ 48,700 lb. t. 2nd Atlantic 37 8KS 1,000 @ 1,200 lb. t	80 lb. payload to 240 mi. altitude.
[illegible]	Rockair	USAF	8 0	0 8	131	1st DM 16 JATO @ 7,800 lb. t.	Air-launched 40 lb. payload.
[illegible]	Deacon	NASA	0 2	0 5	143	1st HPC ABL X-220 @ 6,000 lb. t.	First successful launch 1947 used in wide variety of experiments.
[illegible]	Asp I	Navy	12	0 5	210 4	1st—Marquardt apr @ 5,850 lb. t	Carried 50 lb payload to 30 mi. altitude
	Asp IV	Navy	12	0 5	210	1st—Marquardt apr @ 2 750 lb. t	Capable of lifting 50 lb. payload 50 mi high.
	Aspan 100	USAF	26 1	1 4	1 000	1st—HPC ABL M5 @ 48 700 lb. t. 2nd—Marquardt apr @ 5 850	Nike 1st stage Asp 1 2nd stage
	Aspan 300	Navy	20 4	1 4	1 553	1st—HPC ABL @ 48,700 lb. t 2nd—Marquardt apr @ 5 850	Capable of lifting 60 lb payload 200 mi high
	Bos	USAF	30	1 0	6 600	1st—HPC ABL M6 @ 86 000 lb. t 2nd—HPC ABL M5 @ 48,700 lb. t 3rd—HPC/ABL M5 @ 48,700 lb. t	Designed to lift 500 lb payload 75 mi high
	Nike Nike	USAF	22 2	1 3	5 000	1st HPC ABL M5 @ 48,700 lb. t. 2nd—HPC ABL M5 @ 48 700 lb. t	Also called Python.
	Rocksonde 200	USAF Army	5 3	4	22 5	1st—Marquardt apr @ 2,000 lb. t	Designed to lift payload 40 mi. high.
North American Aviation Co. Rocketdyne Div Los Angeles Calif	Aeolus 1-90	Navy	4 23	0 35	41	1st—NAA @ 315 lb. t	
	Aeolus 1 600	Navy	7 27	0 35	60	1st NAA @ 600 lb. t	

Abbreviations:
GCR Grand Central Rocket Co.
HPC ABL—Hercules Powder Co. Allegheny Ballistics Laboratory
NAA—North American Aviation, Rocketdyne Div

USSR Military and Civil Aircraft

Mission	Designation	NATO Code name	No. of crew	Over-all span, ft.	Over-all length, ft.	Gross weight, lb.	Powerplant: No. designation and max. power each engine	Max. speed mph	Service ceiling, ft	Armament: No. and type weapons	Remarks
STRATEGIC BOMBERS		Blinder	3	70	138	175 000	2 x rear-mounted axial tj.	1 300	60 000	ASM	Formerly called Beauty & Bullshot. Extensive photo equip. indicates strike/recon aircraft.
		Bounder		80	197	200 000	4 x D 14 tj @ 25 600 lb. t	700	55 000		Subsonic cruise used as engine test bed and tanker not in production. Vladimir Myasichev design
	Tu-20	Bison		170	140	350 000	4 x AM-209 tj @ 19,500 lb. t.	610	47 000		Equipped for aerial refueling.
	Tu-95	Bear		180	150	370 000	4 x NK 12 @ 12 000 shp	580	40 000	ASM	Range about 8,000 mi modified to carry 1,000 mi. range missile
	Tu-16	Badger		100	105	150 000	2 x AM-209 tj @ 16,500 lb. t	600	50 000	ASM	Modified to carry 400 mi. range missile. Sold to Indonesia
TACTICAL BOMBERS	Yak-?	Firebar	3	40	55	60 000	2 x VK-7 ax. tj. @ 8,800 lb. t.	800	50 000		Modified w radome & ventral fins formerly called Flashlight B in production
	Yak-42	Backfin	3	50 4	101 7	80 000	2 x M-209 @ 20 240 lb.+aft.	900	50 000		Experimental prototype flew summer 1957
	Il-30	Blowlamp	3	57	70		2 x tj @ 17,000 lb. t	750	50 000		55 deg wing sweepback.
	Il-28	Beagle	3	69	65	44 000	2 x RD 45 tj @ 5 000 lb. t.	600	45,000	4 x 23-mm. 2 x 12.7 mm	Satellite production and use.
	Tu-14	Bosun	3	70	60	60 000	2 x VK 1 tj @ 6,000 lb. t.	600	40 000		Navy torpedo bomber
FIGHTERS	Mig-?	Flipper	1	40	55		2 x axial tj + rocket	1 600	55 000	AAM	Delta wing large airborne radar, two-stage air-to-air missiles. FAI 100 km world record average 1 400 mph.
	Yak ?	Fiddler	2	72'	100	100 000	2 x shoulder mtd axial tj.	1 700	60 000	AAM	Long range interceptor w large aay & intercept radar. Formerly called Flinder
	Yak-28	Flashlight A	2	40	55	30 000	2 x VK-7 ax tj @ 8 800 lb. t	700		4 x 37-mm	Standard operational all weather fighter
	Yak 25	Flashlight C	2	40	55	30 000	2 x VK-7 ax. tj	800	50 000	Missiles	Swept wing version of Flashlight A
	MiG 21	Faceplate	1	33	50		1 x axial tj @ 22,000 lb. t	1 200	60 000		Operational.
	MiG 19	Farmer	1	36 0'	44 3'	27 000	2 x VK 7 ax. tj @ 8 000 lb. t +alt	900	55 000	2 x 23-mm	Low-set slab tail deployed to China Poland Hungary, E. Germany Egypt Iraq & Cuba.
	MiG-17	Fresco	1	32	37	15 000	1 x VK-1A tj. @ 6,850 lb. t.	M>1	50 000	2 x 23-mm	Satellite reproduction and use to max. 15 000 built
	Su-10	Fitter	1				1 x axial tj @ 22,000 lb. t	1 000		Rockets	Competitor to MiG-21 not in production used area rule
	Su-15	Fishpot	1	25	60		1 x axial tj @ 22 000 lb. t.	1 300	60 000	AAM	Delta 5-in dia. tailpipe, all-weather in production
	MiG ?	Fishbed	1				1 x axial tj @ 22 000 lb. t.	1 300	60 000	AAM	Operational in USSR Hungary Poland East Germany
HELICOPTERS	Mi-6	Hook	2			88 000	2 x Sol @ 5,000 lb. t	100			Held FAI 100 km. speed record 186.5 mph has carried 24 000 lb. payload to 7 500.
	Mi ?	Harke	3				4 x Sol @ 5,500 lb. t.				Flying Crane lifted 30,000 lb payload to 7 220 ft.—FAI record
	Mi-4	Hound	2	60'		12 015	1 x ASh-82V @ 1 700 hp.	130	11 800	None	Aeroflot uses 10-place Mi-4P
	Mi-3		4	47'	39	5 180		144			Mi-1T development
	Mi 1	Hare	4	48 0'		4 558	1 x ASh-26P @ 575 hp	100	14 750		Range 400 miles
	Ka ?	Hoop	2	100			2 Ivchenko gas turbines @ 5 700	227 42			Twin-rotor twin prop. convertiplane holds FAI convertiplane speed record.
	Ka ?	Harp	2				2 x axial tj			ASM	ASW role radar
	Ka 18	Hog		32' 8'		2 000	1 x 275 hp.	100	11 500		Coaxial rotor 4 passengers.
	Ka-15	Hen		32' 8'			1 x 225 hp	93	9 800		Coaxial rotor 2 passengers
	Ka 10	Hat	1			440	1 x 55 hp.		5 000		Coaxial rotor
	V 8	Hip						124			Turbine-powered development of Mi-4 26 passengers.
	V ?						2 x turboshaft				Turbine powered development of Mi 1 5 passengers.
	Yak 24	Horse	4	69'	75	35 000	2 x ASh-82B @ 1 430 hp			None	Plush seat civil executive transport for Aeroflot is designated Yak-24K
	Yak-24A	Flying Bus				29 000	2 x ASh-82B @ 1 600 hp.	100	13 000		
TRANSPORTS	An-24	Coke	2	95	20' 4'	41 000	2 x Ivchenko tj @ 2,000 shp	311	20 000		Operates from sod and dirt runways.
	An-16				131		1 x NK & AI tj @ 1,000 shp	328		None	130 passengers similar to An 10.
	An 14	Clod	1	55	36	7 050	2 x AI 14R @ 260 hp.	115	16 100	None	STOL plane Little Bee
	An 12	Cub	3-5	124 8'	121 4'	121 500	1 x NK&AI tp. @ 4 000 shp	150	30 000	Tail turret	Military version of An 10
	An-10	Cat	3-5	124 8'	121 4'	121 500	4 x NK&AI tj @ 1 000 shp.	450	30 000		85 passengers An 10-A carries 100 also a cargo version.
	An 1	Camp				77 150	2 x NK tp. @ 4 000 shp			Tail turret	Assault transport Aeroflot freighter
	An 2	Colt	2	54	35	11 000	1 x ASh 62IR @ 1 000 hp	157	27 800	None	Biplane
	Il 18	Coot	3-5	122	117	124 000	4 NK&AI tj @ 1 000 shp	400	33 000	None	75 100 passengers 2 500 mi range
	Il 14	Crate	2-5	104	70	38 100	2 x ASh 82T @ 1 900 hp.	298	1 000	None	16-12 development replacement
	Il 14M	Crate	2-5	104	70	38 400	2 x ASh 82T @ 1 900 hp	207		None	24 passenger version.
	Il 12	Coach	2 5	104	70	38 000	2 x ASh 82FNV @ 1 850 hp.	252		None	USSR, Polish Czech airlines
	Tu 124	Cookpot				240 000	2 x rad turbofans @ 8,500 lb t.	620	35 000		Medium range transport.
	Tu 114	Cleat	4	177	154	398 000	1 x NK 12M tp @ 12,000 shp	550	35 000	None	Moscow-N Y nonstop with 100 pass.
	Tu 111D			180' 8'		240 000	1 x NK 12M tp. @ 12,000 shp				
	Tu 104	Camel	2	114	121	120 152	2 x M-209 tj @ 14 880 lb. t.	560	33 000	None	ICAO range 1 988 mi.
	Tu-104A	Camel A	3	113	127	165 000	2 x AM-3 tj @ 15 000 lb. t	600		None	73 passengers
	Tu-104B		3	144	124' 8'	165 000	2 x AM-3 tj @ 19 000 lb. t	560			100 passengers
	Tu 104F		5				2 x Turbofans @ 25,000 lb. t	631			120 pass. nr completion of flight test.
	Tu 70	Cart	4	141	110		4 x ASh-82FNV @ 1 850 hp.	215		None	Tu-4 development (B-29 copy)
	Li-2	Cab	5	95	64		2 x M-62R @ 1 000 hp.				USSR built Douglas DC-3.
TRAINERS	Yak-32	Mantis	2				1 x Tumansky 3 000 lb. ax. tj				
	Yak 18A	Max	2	34 8'	28'		1 x radial piston	161	16 597		Tricycle gear
	Yak-18P		2	34 8'	27	2 148	1 x AI 14R @ 260 hp.	1?1	21 326		Tricycle gear

Abbreviations
AAM Air-to-Air Missile
AM—A. A. Mikulin
An O. K. Antonov
ASh A. D. Shvetsov
ASM Air-to-Surface Missile
Il Sergei Ilyushin
AI A. G. Ivchenko
Ka Nicolai Kamov
M—Motor old designation
MIG—Artem Mikoyan & Mikhail Gurevich
Mi Mikhail Mil
NK N D Kuznetsov
Sol Soloviev
Su Pavel Sukhoi
tj—turbojet engine
tp—turboprop engine
Tu Andrei Tupolev
VK V Klimov
Yak—Aleksandr Yakovlev
aft.—afterburner
Rezar Dieseler

U.S. Civil and Military Rotary-Wing Aircraft

Manufacturer and Address	Model Number	Designation	No. of Crew	No. of Passengers	Rotor Diameter	Max. Length of Blades Unfolded	Over-all Height to Top of Rotor	Weight Empty lb	Max. Gross Weight	No., make, model and max. rating	Max. Speed, mph at Altitude, ft	Hovering Ceiling in Ground Effect, ft	Normal Still-air Range, mi	Remarks
Bell Helicopter Company, Ft. Worth, Texas	47G-2	Trooper	1	2	35'	1"11 5"	9' 5"	1 544	2 450	1 Lyc. VO-435 @ 200 hp.	100 @ S.L./1 000	10 850	238	Army H-13H
	47G-3A	Trooper	1	2	37'	2"41 5"	9' 4"	1 638	2 850	1 Lyc. VO-435 @ 260 hp	105 @ S.L.	8 500	228	Based on 2 800 lb. GW
	HTL-7		1	1	37'	2"43 4"	9' 4"	1 810	2 565	1 Lyc. O-435 @ 240 hp.	103	6 200	184	Instrument Trainer
	47G-3B	Super Trooper	1	2	37'	2"41 2"	9' 1"	1 600	2 850	1 Lyc. TVO-435 @ 240 hp.	105 @ S.L.	15 400	200	Based on 2 850 lb. GW
	47J-2	Ranger	1	3	37'	2"43 1"	9' 3"	1 730	2 850	1 Lyc. VO-540 @ 260 hp.	105 @ S.L.	6 200	250	
	HU-1B	Iroquois	1	7-9	44	53'	12' 8"	4	8 500	1 Lyc. T-53 @ 960 shp	120 @ S.L.	10 150	248	
	YHU-1D	Iroquois	1	11	44	43 11"	12			1 Lyc. T-53-L-9 @ 1100 hp.				
	204 B		1	9	44	53'	12' 8"	4 318	8 500	1 Lyc. LTC 1K-4 @ 1100 hp.	138 @ S.L.	10 500	250	
	250/HO4	LOH	1	3						1 Allison T63-A-5 @ 250 hp.				
Bensen Aircraft Corp., Raleigh, N.C.	B-8	Gyroglider	1	1	20'	20	6' 4"	105	475	None	90 @ S.L.	NA	NA	Towed rotorcraft
	B-8W	Hydroglider	1	1	20	20	7' 4"	110	900	None	90	NA	NA	Towed rotorcraft
	B-9B	Gyroboat	1	2	21	21	5' 9"	175	650	None	60	NA	NA	Towed rotorcraft
	B-8M	Gyrocopter	1		21	21	6' 4"	250	500	1 McCulloch 4318-E @ 72 hp.	85			Pusher autogyro
	B-9	Little Zipster	1	1	22	22	11' 6"	255	800	1 Kiekhaefer Mk. 78 @ 70 hp.	65 @ S.L.	6 000	100	Coaxial helicopter
Brantly Helicopter Corp., Frederick, Okla.	B-2		1	1	23' 1"	1"27 9"	6' 11"	930	1 600	1 Lyc. VO-360-A1A @ 180 hp.	100 @ S.L.	4 000	400	All-metal
Cessna Aircraft Co., Wichita, Kansas		Skyhook	1	1	35'	12 8"	8' 5"	2 050	3 100	1 Cont. FSO-526 @ 270	122 @ S.L.	9 600	200	Commercial version
Del Mar Engineering Laboratories, Los Angeles, Calif.	DH-1A	Whirlymite Scout	1	0	16'	18' 4"	7' 2"	175	400	1 derated Kiekhaefer Mercury 850 @ 36 hp	74 @ S.L.	7 000	90	Also mounted on ground training system
	DH-2A	Whirlymite Scout	1	0	16'	18' 1"	7' 2"	220	600	1 Solar T-62T-15 @ 60 hp.	77 @ S.L.	5 000	34	
Doman Helicopters, Danbury, Conn.	D-10A		1	7	48'	58' 6"	10' 6"	3 327	5 500	1 Lyc. IHO-720-A1A @ 400 bhp	107 @ S.L.	6 400	354	Supercharged engine
	D-10B		1	7	48'	58' 6"	10' 6"	3 377	5 500	1 Lyc. IHO-720-A1A @ 400 bhp + turbocharger	107 @ S.L.	11 200	354	AiResearch turbocharger
R. J. Enstrom Corp., Menominee, Mich.	F-28		1	2	32'		9' 1"	1 200	1 850	1 Lyc. O-360 @ 180 hp.	100 @ S.L.	6 000	274	
Gyrodyne Co. of America, St. James, N.Y.	RCA-41A	YRON-1	1	0	17	17	8'	430	825	1 Porsche YO-95-2 @ 62 hp	68 @ S.L.	4 300	56	
	RCA-41B	YRON-1	1	0	17	17	8'	425	715	1 Solar T-62 @ 62 hp	72 @ S.L.	10 300	18	
	RCA-21	YRON-1	1	0	20'	20	8	535	910	1 Porsche YO-95-6 @ 72 hp	77 @ S.L.	7 300	112	Lasseau motorcycle
	DSN-1,2,3	(For details see Drone Table)												
Hiller Aircraft Corp., Palo Alto, Calif.	H-23D	Raven	1	2	35'	5"40' 6"	9' 9"	1 816	2 700	1 Lyc. VO-435 @ 250 hp	95 @ S.L.	8 200	202	Army
	12E		1	2	35'	5"40' 6"	9' 9"	1 760	2 800	1 Lyc. VO-540 @ 305 hp	90 @ S.L.	10 000	225	Commercial
	F-4	H-23F	1	3	35'	5"42 6"	9' 9"	1 775	2 750	1 Lyc. VO-540 @ 305 hp	95 @ S.L.	10 000	225	Civil & military
	Ten99	Ten99	1	5		39	10		4 500	1 P&W PT6 @ 500 hp.				Civil & military
	1100	HO-5	1	3										Army observation
Hughes Tool Co., Aircraft Div., Culver City, Calif.	269A		1	1	25	28'	8'	910	1 550	1 Lyc. O-360-C2D	90 @ S.L.	8 300	210	[illegible]
Kaman Aircraft Corp., Bloomfield, Conn.	H-43A	HOK-1	1-2	3-4	47'		12' 5"	4 430	5 850	1 P&W R1340 @ 600 hp.	110 @ 1,000	14 300	235	Rescue, also HOK-1
	H-43B	Huskie	1-2	11	47	47	12' 7"	4 800	8 150	1 Lyc. T53-L-1B @ 860 shp.	120 @ 1 500	25 000	250	Rescue
	HU2K-1	SeaSprite	2	10-14	44	52' 2"	13' 8"	5 435	9 340	1 G.E. T58-GE-8B @ 1250 shp.				SAR utility
	K17		2	6	32'	37	8' 6"	1 104	1 800	1 Turbomeca Turmo 360 @ 400 shp.	84 @ S.L.		150	Propulsion research
Kellett Aircraft Corp., Willow Grove, Pa.	KD-1A		1	1	40'	38	10' 9"	1 500	2 200	1 Jacobs L-4MA @ 225 hp.	110 @ S.L.	14 000	150	Autogiro.
	KD-10		1	1	40'	34	9' 11"	1 755	2 800	1 Lyc. IO-320 @ 200 hp.	138 @ S.L.	24 000	420	Autogiro.
Lockheed Aircraft Corp., Burbank, Calif.	CL-475		2		32'				2 000	200-150 hp				Rigid rotor
Omega Aircraft Corp., New Bedford, Mass.	BS-12D-1		1	4	39'	39	13	3 212	4 750	2 Lyc. O-540-F1B5 @ 235 hp.	150 @ 1 500	1 500	195	
Piasecki Aircraft Corp., Philadelphia, Pa.	16H		2	3	44	44	10' 8"	2 811	4 500	1 P&W PT6 @ 500 shp.		10 500	450	
Republic Aviation Corp., Farmingdale, N.Y.		Lark	1	1	33'	5"31 10"	10'	1 840	4 000	1 Turbomeca Artouste II @ 450 shp	110 @ 14 500	15 300	335	Sud Alouette Built under lic.
Sikorsky Aircraft, Stratford, Conn.	S-55A	H-19B&D	1	2 10	53	42 3"	13' 4"	5 250	7 500	1 Wr. R1300-3 @ 800 hp.	112 @ S.L.	3 800	180	HRS-3, HO4S-3
	S-55C	H-19A&B	1	2 10	53	42 3"	13' 4"	4 950	7 200	1 P&W R1340-57 @ 600 hp.	101 @ S.L.	2 000	400	HRS-1&2, HO4S-1&2
	S-56	H-37A	2-3	23	72	88	17' 1"	20 850	31 000	2 P&W R2800-54 @ 2 100 hp.	130 @ S.L.	7 600	145	HR2S-1
	S-58B	H-34A	1-2	18	56	65 10"	14' 7"	7 640	11 000	1 Wr. R1820-84 @ 1 525 hp.	123 @ S.L.	4 500	182	HSS-1, HUS-1
	S-61	HSS-2	4		62	72 6"	16' 7"	10 824	17 300	2 GE T-58-8 @ 1 250 shp.	150 @ S.L.	8 700	580	Amphibious
	S-61L		2-3	28	62	72 3"	16' 7"	11 311	19 000	2 GE CT-58-110-1 @ 1 350 shp.	150 @ S.L.	6 760	250	Civil transport
	S-62A		1-2	10	53	62 3"	14' 2"	4 580	7 500	1 GE CT-58-100-1 @ 1 050	109 @ S.L.	14 000	235	Coast Guard HU2S-1
	S-64	Skycrane	3	10	72'	88 6"	18' 7"	17 240	38 000	2 P&W JFTD12A @ 4 050	152 @ S.L.*	6 750	161	
Umbaugh Aircraft Co., Ocala, Fla.	18A		1	1	35	26 3"	8' 0"	1 215	1 600	1 Lyc. O-360-A1A @ 180 hp.	150 @ all alts.		275	
	18B		1	1	35	26 4"	9' 6"	1 210	1 825	1 Lyc. IO-360-A1A @ 200 hp.	115 @ all alts.		280	
	30		1	4	42	31 1"	9' 0"	1 570	2 650	1 Lyc. IO-540-A1A @ 250 hp.	118 @ all alts.		400	
Vertol Div., The Boeing Co., Morton, Pa.	42	H-21A	1-2	14	44	86 4"	15'	8 300	14 500	1 Wr. R1820-103 @ 1 150 hp.	115 @ S.L.	14 000	450	
	43	H-21B	1-2	20	44	86 4"	15'	8 400	15 000	1 Wr. R1820-103 @ 1 425 hp.	140 @ S.L.	9 600	400	
	44	H-21C	1-2	20	44	86 1"	15'	8 500	15 000	1 Wr. R1820-103 @ 1 425 hp.	140 @ S.L.	9 100	400	
	44		2	15-19	44	86 4"	15' 8"	8 950	14 500	1 Wr. R1820-103 @ 1 425 hp.	127 @ S.L.	9 400	250	
	107		2	22	48	4"83 6"	16' 10"	9 100	18 500	2 Lyc. T53 @ 825 shp.	144 @ 100			Civil Transport
	107 II		2	25	50'	83 4"	16' 10"	10 755	18 450	GE CT58-110 @ 1 250 shp.	162 @ S.L.	7 500	280	Marine HRB-1
	114	HC-1B	3	33	59'	1"68' 3"	18' 6"	16 138	33 000	2 Lyc. T55-L-5 @ 2 200 shp	176 @ S.L.	13 400		Chinook

Con. Continental; Fr Franklin; GE — General Electric; Lyc — Lycoming; P&W Pratt & Whitney; RMI Reaction Motors; WR Wright; * — With high external drag load

International Rotary-Wing Aircraft

Manufacturer and Address	Model designation	Name	Seats, incl. crew	Rotor diameter	Length blades folded	Max. height	Weight empty lb.	Normal gross weight, lb.	Number, make, model and max. rating ea.	Fuel capacity gal.	Max. speed, mph	Initial rate of climb, fpm	Hovering ceiling in ground effect, ft.	Service ceiling, ft.	Max. still air range, mi.	Remarks
CZECHOSLOVAKIA Czechoslovak Aircraft Works, Prague	HC-2	Heli-Baby	2	28' 10"	34 4"	8' 4"	838	1 280	1 Praga DH @ 83 hp.	8.8	81	786	3,040	6 610	93	Produced in Otrokovice
	HC-3		5	33'		10' 6"		2 080	1 M108H		100					
FRANCE Helicop-Air, Paris	L50	Girhel	2	32'					1 Con. C90 @ 90 hp							
	L51	Girhel	2	32' 6"		8' 10"	615	1 650	1 Lyc. O-320 @ 150 hp		112				620	
Sud Aviation	S.E. 3130	Alouette II	5	33' 6"	31' 9"	9'	1 874	3 300	1 Turbomeca Artouste II @ 450 shp.	152	106	980	11 150	14 300	316	Republic License in U.S.
	S.E. 3160	Alouette III	7	36' 1"	33' 6"	6' 8"	2 359	4 630	1 Turbomeca Artouste III @ 870 hp.	157	118	900	16 700	14 000	300	
	S.O. 1221	Djinn	2	36'	17' 0"	9'	750	1 570	1 Turbomeca Palouste IV @ 528 shp., tip jet		80	5 000	3 280	27,360	140	Republic License in U.S.
	S.F. 3210	Frelon	24	52'	38' 9"	15' 5"	13 230	20 476	3 Turbomeca Turmo III C @ 1320 hp.		90					
	S.E. 3200	Frelon							3 Turbomeca @ 810 shp.		31					
GREAT BRITAIN Westland Aircraft, Ltd. Bristol Helicopter Div. Fairey Aviation Div. Saunders Roe Div. Yeovil		Widgeon	6	46' 2"	40' 10"	13' 4"	4 382	5 900	1 Alvis Leonides 521/2 @ 815 bhp	83	110	770	6 000	11 500	500	
	Series 1	Whirlwind	5	53'	41' 8½"	13' 8½"	5 460	7 500	1 P&W R1340-10 @ 600 bhp	146	110	536	4 700	7 500	304	
	Series 2	Whirlwind	9	53'	41' 8½"	13' 8½"	6 376	8 000	1 Alvis Leonides Major 755 @ 750 bhp.	145	116	1 180	6 600	13 600	300	
	Series 6	Whirlwind	8-10	53'	41' 8½"	13' 2½"	4 700	8 000	1 de Havilland Gnome free Turbine H 1000 @ 1050 shp.	170	110	1 200	16 450	16 450	316	
	Series 1	Wessex	14-16	56'		14' 3"	7 600	12 600	1 Nap. Gaz. N. Ga. 13 free Turbine @ 1450 shp	265	138	1 750	5 600	14 600	390	Anti-sub. Search-strike.
	Series 2	Wessex	14-16	56'		14' 3"	11 932	18 700	2 de Havilland Gnome free Turbine H 1200 @ 1200	300	133	1 500	14 500	17 400	370	Hi-Alt. Troop, Freight Tr.
	—	Belvedere	20-27	48' 11"	—	17' 2"	11 121	16 000	2 Nap. Gaz. N. Ga. 2 @ 1650 shp.	532	138	1 000	0 850	13 000	420	Transport.
	—	Scout	5-6	32' 3"		10' 4"	4 340	6 500	1 Blackburn A 129 Mk 3 @ 685 shp	160	127	1 400	17 800	20 000	258	Licence Recon.
	Mk. 12	Skeeter	1	32'		10' 2"	1 876	2 180	1 de Havilland Gipsy Major 215 @ 215 bhp	23	122	1 100	5 800	12 800	214	A.O.P. Liaison.
		Rotodyne	52	104'		28' 2"		58 500	2 Rolls Royce Tyne @ 5250 shp.	1,290	202		6,650	10 000		Prototype.
	S-58*		1 2	56	65' 10"	14' 4"	7 630	13 500	1 Wr. R1820-84 @ 1,525 hp		123		4 500		180	
ITALY G. Agusta Soc. Costruz. Aeron. Cascina Costa (Gallarate) Varese	AB47J		4	37' 2"	32' 4"	9' 4"	1 650	2 850	1 Lyc. VO-435 @ 240 hp.	48	105	630	4 800	6 300	260	
	AB47J2		4	37' 2"	32' 4"	9' 4"	1 780	2 850	1 Lyc. VO-540 @ 260 hp.	48	105	750	9 200	12 130	200	
	AB47J3		4-5	37' 2"	32' 4"	9' 4"	1 750	2 950	1 Lyc. VO-540 @ 270 hp.	48	85	790	4 200	11 500	400	
	AB47G2		3	35' 1"	26' 8"	9' 4"	1 550	2 450	1 Lyc. VO-435 @ 250 hp	42	100	805	10 850	12 300	238	
	AB47G2A		3	37' 2"	31' 7"	9' 4"	1 640	2 850	1 Lyc. VO-435 @ 240 hp.	42	105	590	1 500	9 700	262	
	AB47G3B		3	37' 2"	31' 7"	9' 4"	1 720	2 850	1 Lyc. TVO-435 @ 280 hp.	42	105	860	18 000	18 500	192	
	AB102		8	47' 7"	41' 6"	10' 7"	3,090	5 300	1 P&W R-1340 @ 600 hp.	105	110	800	8 100	12 500	248	
	A104		2	25'	38' 10"	7' 8"	840	1 410	1 M.V. A 100 @ 140 hp	25	103	810	9 600		702	
	AB204B		10	44	38' 6"	12' 5"	4 200	7 500	1 D.H. Gnome H 1000 @ 1000 hp	166	134	2 300	13 000	16 300	350	
Aer Lualdi, Udine	L59		2	35' 1"	40' 11"	9' 10"	1,700	2 580	1 Con. IC-470-D @ 230 hp.	40	100	702	6 570	6 530		
Fiat Aviation Division, Turin	7002		7	30' 5"		9' 8"	1 280	3 650	1 Fiat 4700 Gas Generator @ 500 hp		100			11 100	150	Two-blade rotor
Mazzolini DiCampoleone, Rome		Libellula	1	29' 10"	34' 8"	9' 10"	880	1 430	1 Walter 4 III @ 105 hp.	10	65	630	4 600	7 500	100	Coaxial rotor
JAPAN Mitsubishi Industries Reorganized, Ltd. Chiyoda-Ku, Tokyo	S-55-A*		11-12				4 480	7 200	1 P&W Wasp R1H9 (R 1340-57)		110					
	S-55-C*	—	11-12				5 160	7 500	1 Wright (R-1300-3)		101					
NETHERLANDS Nederlandse Helicopter Industrie N.V. Papendrecht	H-3	Kolibrie	2	33'	33'	9'	560	1 540	2 NHI TJ-5A Ramjet @ 62 hp	100	76	740	6 900	11 000	45	Agriculture.
POLAND Aircraft Construction Center, Swidnik	SM-2		5	47'	55' 7½"	10' 10"	4 000	6 380	1 AI-26V @ 575 hp.		90	880	9 502	13,100	217	Polish version of Mil MI-1
	BZ-4	Zuk	4	30' 4½"	41' 10"	8' 6½"	2 310	3 300	1 Narkiewicz WN @ 300 hp.	44	97	900	1 970	5 580	161	
WEST GERMANY Bolkow Entwicklungen, Ottobrunn Bei Munchen		BO-102	1	21' 0"			—	882	1 Agusta @ 60 hp		67	—			600	Trainer

* Built under license

U.S. STOL & VTOL Aircraft

Manufacturer and Address	Designation	Type	No. of seats	Span	Length	Height	Wing area, sq. ft.	Empty weight, lb.	Gross weight, lb.	Number, make, model and max. power, ea.	Rotor-propeller diameter	No. of propellers	Service ceiling, ft.	Maximum speed, mph.	Remarks
	General Data		Dimensions					Weights		Powerplant					
Bensen Aircraft Corp. Raleigh, N. C.	B-10	Prop-Copter	1	7' 2"	10'	4' 0"		390	650	2 McCulloch 4318F 72 hp	4' 3"	*	8 500	80	First flight Aug. 6, '58.
Douglas Aircraft Co. Santa Monica, Calif.	VZ-4DA	Tilt ducts	5	25	32	10'		2 000	2 700	1 Lyc T53 @ 840 shp.		2			U.S. production rights obtained from Doak A. C. Co. which retains rights in rest of world
Helio Aircraft Corp. Norwood, Mass.	H-395 Super Courier	STOL high wing	5	39'	30	8' 10"	231	2 037	3 000	1 Lyc GO-480 @ 295 hp.	8'	1	22 500	180	L-28
	H-395A Courier	STOL high wing	5	39'	30	8' 10"	231	2 020	3 000	1 Lyc GO-435 @ 260 hp	8' 6"	1	20 000	170	
Hiller Aircraft Corp. Palo Alto, Calif.	X-18	Tilt wing	2	48'	63	24' 7"		33 000		2 All YT40-A-11	16'	2		250	Testbed for USAF
Kaman Aircraft Corp. Bloomfield, Conn.	K-16B			34	36' 4"	14' 4"	231			2 GE YT58-8 @ 1,050 shp.	16'	2			Navy flight research.
Lanier Aircraft Corp. Marlton, N. J.	Paraplane Super Commuter		5	27	22' 11"	6' 6"	188	1 600	1 700	1 Lyc O-360 @ 180 hp		1		165	
	Paraplane Super Commuter 4		4	27' 11"	22' 11"	9' 0"	179	1 300	2 200	1 Lyc IO-360 @ 200 hp		1	22 500	160	
Ling-Temco-Vought Dallas, Texas	VHR 117	Exp. Tri-Service transport	23	67' 6"	58'	20				4 GE T64-GE-6 @ 2850 shp.					L-T-V Hiller/Ryan joint project
Lockheed-Georgia Co. Marietta, Ga.	BLC-130	Boundary layer	92	132' 7"	99' 10"	38' 1"	1 745	73 150	135 000	4 All. T56A-7 @ 4050 shp. and 1 Con. 356-7 Air Flow 30 lb. sec. in	13' 6"	4	37 000	300	Testbed flying.
	L-330	VTOL	2	25' 6"	36' 8"	11' 10"	108	4 095	7 200	2 P&W JT12A-3 @ 3000 lb. t			40 000	520	Army VZ-10
Piasecki Aircraft Corp. Philadelphia, Pa.	VZ-8P	Ducted fan	4	9' 5"	26' 1"	8' 8"		2 000	2 350	1 Con. Artouste IIB @ 425 shp.					Tactical ground support
	PA-59H	Ducted fan		9' 3"	24' 5"	8' 10"		2 000	2 670	2 Con. Artouste IIB @ 425 shp.					VZ-8P with ground powered wheels.
	PA-4A	Quadrotor		22' 3"	22' 3"	6' 8"			2 000	Lyc VO-435-A1B @ 260 hp					Radio-controlled drone
	PA 94	STOL high wing		75	71	20			44 000	4 GE T58-5 @ 1250 hp					Deflected slipstream STOL
Robertson Aircraft Corp. Ft. Worth, Texas Also Fla.	M-255	Vectored slipstream and pure jet	6-7	24	33		9' 4"	144	5 400	8 000	2 SO-580 Lyc & 2 Tlt J-46 Turbojets	8' 10"	2			First flight 1958.
	M 400 SQR	Vectored slipstream	6-7	40	37				2 600	5 000						Currently under Army Flight Test Contract.
	M 410 SRV	VTOL													Swept wing outer panels minimum trim change between hovering and forward flight
	M-233	Tilt jet VTOL													Supersonic test bed Engines tilt pyramidally to provide three-axis hover control
Lehigh Acres, Fla.	Model CD-3	Tip rocket													Test bed
	Model 310	SCAT													Survival craft as transport.
Ryan Aeronautical Co. San Diego, Calif.	VZ-3RY	Vectored slipstream	1	26' 8"	27' 8"	10' 8"			2 600	1 Lyc T53 @ 850 shp.		2			
	VZ-11									2 GE J85 @ 2650 shp.	5				Lift fan.
Vanguard Air & Marine Corp. Paoli, Pa.	Model 2D	Fan in wing with ducted pusher prop.	0	22'	30' 8"	9' 1"			3 100	1 Lyc T53 @ 825 shp.	8' 6"	2			Testbed. Wing buried rotor props. In test phase.
Vertol Division The Boeing Co. Morton, Pa.	VZ-2	Tilt wing	2	24' 11"	26' 5"	16'	119	2 300	3 200	1 Lyc T53 @ 825 shp.	9' 6"	0			Numerous conversions made

Military definition of VTOL aircraft is one which can clear a 50-ft. obstacle 50-ft. from start of takeoff. STOL aircraft is one which can clear a 50-ft. obstacle 500 ft. from start to takeoff. Many VTOL aircraft can also function as STOL types, carrying higher payloads in latter configuration. Army-Navy-Air Force VTOL and STOL projects embrace wide variety of propulsion and lift schemes. Most are test beds providing flight research data for future operational vehicles.

Abbreviations
All. — Allison
Con. — Continental
GE — General Electric
Lyc. — Lycoming.
P&W — Pratt & Whitney Aircraft.

* U.S. Army Flying Platforms; dimension given (span) is width of vehicle.

U.S. Civil and Military Transports

Manufacturer and Address	Model	Name	No. of crew	No. of passengers	Cargo capacity, cu. ft.	Number, make, and model of powerplants	Maximum speed, mph.	Best cruise speed, mph.	Landing speed, flaps and landing gear down, mph.	FAA field length, takeoff, ft.	FAA field length, landing, ft.	Maximum still-air range, mi.	Weight empty, lb.	Maximum gross weight, lb.	Maximum landing weight, lb.	Wingspan	Overall length	Maximum height
	Basic Data						Performance						Weights			Dimensions		
The Boeing Co. Renton, Wash.	707-120	Jet Stratoliner	3-4	100-179	10 200	4 P&W JT3C-6	615	540	165	10 800	6 200	3 550	118 640	258 000	185 500	130' 11"	144' 6"	38' 5"
	707-120B	Jet Stratoliner	3-4	100-179	10 200	4 P&W JT3D-1	625	540	157	8 000	6 000	4 110	120 734	258 000	185 500	130' 11"	144' 6"	38' 8"
	707-220	Jet Stratoliner	3-4	100-179	10 200	4 P&W JT4A-3	625	533	167	8 400	6 200	2 [illegible]	117 100	218 000	185 000	130' 11"	144' 6"	38' 5"
	707-320	Intercontinental	3-4	103-189	28 250	4 P&W JT4A-11	615	525	164	10 700	7 300	5 374	132 921	316 000	207 000	142' 5"	152' 11"	38' 8"
	707-320B	Intercontinental	4	104-189		4 P&W JT3D-3	625	530	147	9 500	5 450	8 235		328 000	207 000	[illegible]	[illegible]	38' 5"
	707-420	Intercontinental	3-4	103-189	28 250	4 R.R. Co 12	615	525	164	10 500	7 300	5 501	131 241	316 000	207 000	142' 5"	152' 11"	38' 5"
	720	Jet Stratoliner	3	88-149	10 580	4 P&W JT3C-7 4 P&W JT3C-R	625	532	149	9 250 8 100	5 200	3 815 3 633	84 000	230 000	175 000	130' 11"	136' 2"	38'
	720B	Jet Stratoliner	3	88-165	17 050	4 P&W JT3D-1	625	535	151	6 000	5 700	4 284	110 778	235 000	158 000	130' 11"	136' 1"	38'
	727		3	70-114	24 000	3 P&W JT8D	620	590		5 700		1 865	81 000	142 000	131 000	108' 7"	114' 4"	33' 5"
	C-135A	Stratolifter	4	86+	87 000	4 P&W J57P-59W	600+							270 000		130' 11"	134' 6"	41' 8"
	C-135B	Stratolifter	4	86+	87 000	4 P&W TF33-P5	600+							271 000		130' 11"	134' 6"	41' 8"
	KC-135A	Stratotanker	4	80+	83 000	4 P&W J57P-59W	600+							297 000		130' 11"	136' 4"	41' 8"
General Dynamics Convair San Diego, Calif.	880		3	88-110	8 630	4 GE CJ805-3	615		138	6 500	5 730	3 200	81 800	184 500	132 300	120'	129' 4"	36'
	880M		3	88-110	8 630	4 GE CJ805-3B	615		138	5 750	4 950	3 756	88 320	191 000	155 000	120'	129' 4"	36'
	990		3	96-121	5 280	4 GE CJ805-23	640		125	5 350	4 760	4 300	110 520	239 000	180 500	120'	139' 8"	39' 6"
	990	Coronado	3	96-121	5 406	4 GE CJ805-23	640		125	5 350	4 770	4 300	110 520	244 000	180 000	120'	139' 6"	39' 6"
	440	Metropolitan	3	44-52		2 P&W R2800-CB-17	310	289	95	5 000	4 910	2 452	31 305	49 100	47 650	105' 4"	79' 6"	28' 2"
	C-131A	Samaritan	3			2 P&W R2800-99W	312						29 000	41 878		91' 9"	74' 8"	27' 3"
	C-131B					2 P&W R2800-103W	293						29 248	47 000		105' 4"	79' 2"	28' 2"
	YC-131C					2 All YT56-A-3	356							47 000		105' 4"	79' 2"	28' 2"
	C-131D		3			2 P&W R2800-103W	314						29 000	[illegible]		105' 4"	79' 2"	28' 2"
Douglas Aircraft Co., Inc. Long Beach, Calif.	DC-8	Series 10	3	116-179	20 850	4 P&W JT3C-6	590	555	118	9 320	5 100	4 120	120 000	273 000	193 000	142' 4"	150' 6"	42' 4"
	DC-8	Series 20	3	116-179	20 850	4 P&W JT4A-3 5-11	600	588	118	8 200	5 100	4 280	122 757	276 000	193 000	142' 4"	150' 6"	42' 4"
	DC-8	Series 30	3-5	116-176	20 850	4 P&W JT4A-9-5-11	600	588	150	10 800	6 330	5 300	126 072	310 000	199 500	142' 4"	150' 6"	42' 4"
	DC-8	Series 40	3-5	116-176	20 850	4 R-R R.Co 15	600	593	148	8 670	6 590	5 935	124 989	315 000	207 000	142' 4"	150' 6"	42' 4"
	DC-8	Series 50	3-5	116-156	20 846	4 P&W JT3D-3	600	585	150	9 720	6 590	5 930	124 521	310 000	199 500	142' 4"	150' 6"	42' 4"
	DC-8F	Jet Trader	3-5	114-153	94 113	4 P&W JT3D-3	600		158	9 350	7 440	7 650	129 151	315 000	240 000	142' 4"	150' 6"	42' 4"
Fairchild Stratos Corp. Hagerstown, Md.	F-27A	Friendship	2	10-44		2 R.R. Mk 528-7E		300	91	4 550	1 410	1 516	23 314	38 100	37 500	95' 2"	77' 1½"	27' 6"
	F-27F		3	10-25		2 R.R. Mk 529-7F		300	93	4 000	2 000	2 840	21 901	38 100	37 000	95' 2"	77' 1½"	27' 6"
	F-27	Cargo transport	2		12 000+	2 R.R. Mk 528-7E							22 278	42 000	37 500	95' 2"	77' 1½"	27' 6"
	F-27G	Mil Transport	2	40-44	12 000+	2 R.R. Mk 528-7F	327						23 070	42 000	37 500	95' 2"	77' 1½"	27' 6"
Grumman Aircraft Eng. Corp. Bethpage, N. Y.	TF-1	Trader	2	9	3 000	2 W.R. R1820-82							18 638	24 640		69' 8"	42'	16' 3"
Lockheed Aircraft Corp. Marietta, Ga.	C-130A	Hercules	4	92	36 000	4 All T56-A-9	375	350	110			1 830	55 500		124 200	132' 7"	97' 10"	38'
	GC-130A	Hercules	6			4 All T56-A-9	385	340	110			575	57 500		124 200	132' 7"	97' 9"	38'
	RC-130A	Hercules	8	24		4 All T56-A-9	375	350	112				63 300		121 200	132' 7"	97' 9"	38'
	C-130B	Hercules	4	92	35 000	4 All T56-A-7	375	350	115			2 210	67 200		135 000	132' 7"	97' 9"	38'
	JC-130B	Hercules	7			4 All T56-A-7	375	350	115			1 090	71 200		135 000	132' 7"	97' 9"	38'
	SC-130B	Hercules	8	44	30 500	4 All T56-A-7	375	350	115			2 240	67 350		135 000	132' 7"	97' 9"	38'
	C-130D	Hercules	4	92	30 000	4 All T56-A-9	350	225	100			1 725	65 500		124 200	132' 7"	97' 9"	38'
	C-130E	Hercules	4	92	32 700	4 All T56-A-7	365	345	115			3 740	69 850		155 000	132' 7"	97' 9"	38'
	C-130 BL	Hercules	4	92	32 400	4 All T56-A-7	360	335	115			3 050	73 300		125 000	132' 7"	97' 9"	38'
	GV-1	Hercules	7	92	31 000	4 All T56-A-7	365	340	115			345	66 050		135 000	132' 7"	97' 9"	38'
	[illegible]	Hercules	5	92	34 217	4 All T56-A-7	375	350	110			2 240	66 600		135 000	132' 7"	97' 9"	38'
	C-140A	JetStar	5			4 P&W J60-P-5	575	545	125			2 350	20 550		38 000	54' 5"	60' 5"	20' 5"
	C-140B	JetStar	5	8	1 890	4 P&W J60-P-5	575	545	125			2 550	20 550		30 000	54' 5"	60' 5"	20' 5"
	VC-140B	JetStar	6	8	1 010	4 P&W J60-P-5	575	545	125			2 550	19 925		30 000	54' 5"	60' 5"	20' 5"
	1329	JetStar	2	8	3 243	4 P&W JT12A-6	595	545	125	6 200	5 300	2 350	19 900	18 921	30 000	54' 5"	60' 5"	20' 5"
	C-141A		4	154	93 000	4 P&W TF33-P-7	550	505	125	5 000	6 400	4 10	132 700		315 000	160' 1"	143'	39' 4"
	400		4		93 000	4 P&W JT3D-8A	550	505	125	6 000	6 400	1 500	111 800		285 500	160' 1"	143'	39' 4"
Burbank, Calif. Div.	188	Electra	3-4	66-98		4 All 501-D-13	450	405	120	5 250	4 000	3 400	57 300	116 000	98 650	99'	104' 6"	33'

EASTERN AIR LINES' BOEING 720s

U.S. Gas Turbine Engines

Manufacturer and Address	Designation	Type**	No. of compressor stages axial centrifugal	No. of turbine stages	No. of combustors	Max. power at S. L.	Specific fuel consumption at max. power lb./hr./lb. t. or shp.	Compression ratio at max. rpm	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
Avco Corp., Lycoming Div., Stratford, Conn.	T53-L-1A	ACFS	5, 1	1		860 shp	0.755	6.0	23	47.61	460	Bell HU-1A, Kaman H-43B
	T53-L-3	AFP	5, 1	1		960 shp.	0.680	6.0	23	58.48	524	Grumman AO-1
	T53-L-5	ACFS	5, 1	1		960 shp	0.665	6.0	23	47.60	487	Bell HU-1B
	T53-L-7	AFP	5, 1	1		1 100 shp	0.646	6.0	23	47.60	540	Advanced Grumman AO-1
	T53-L-9	ACFS	5, 1	1		1 100 shp	0.661	6.0	23	47.61	488	Bell 204
	T55-L-5	ACFS	7, 1	1		2 200 shp.	0.660	6.3	24.25	45.21	576	Vertol YHC-1B
	LTC4G-1	AFP	7, 1	1		2 445 shp.	0.612	6.1	24.75	62.22	795	VTOL powerplant
The Boeing Company, Seattle, Wash.	502-10VB	CFS	1	2	2	300 shp	0.98	4.55	24	40	345	Turboshaft
	502-12B	CFG	2	2	2	205 shp.		3.5	26	42	410	Compressed air output
	502-16	CFS	2	2	2	375 shp	0.78	4.8	23	34	215	Turboshaft
	520-6	CFS	1	2	2	550 shp.	0.65	6	25.5	35	290	Turboshaft
	T50-BO-4	CFS	1	2	2	270 shp	1.02	4.4	24	41.5	134†	Navy DASH anti-submarine destroyer-carried drone helicopter program
	T50-BO-6	CFS	1	2	2	300 shp.	0.98	4.50	24	40	125†	
	T50-BO-10	CFS	1	2	2	330 shp	0.85	4.48	23	34	221†	(As above)
	T60 (520-21)	CFS	1	2	2	440 shp	0.72	6.25	25.5	37.32	176	Helicopter type
Continental Aviation & Eng'g Corp., Detroit, Mich.	J69-T-25	CFJ	1	1	1	1 025 lb. t	1.14		24.1	50	364	Cessna T-37B, CJ69-1000
	J69-T-29	ACFJ	1, 1	1	1	1 700 lb. t	1.10			40.3	334	Ryan Q-2C
	J69-T-39	ACFJ	3	2	1	2 550 lb. t	0.90	6.1	22.3	44	358	Target missile engine
	J100-1400	ACFJ	5	1	1	1 400 lb. t	1.04	5.1	22.3	44	370	
	T72-T-2 (217-5A)	ACFP	1, 1	3	1	600 shp	0.67		18.38	42.48	210	6 000 rpm turboshaft, Republic Lark
	217-6A	ACFS	1, 1	3	1	500 shp	0.67		18.38		230	2 100 rpm turboprop
	227-1	ACFS	2	1	1	250 hp	0.71	5.28	18.4	35.2	130	
	141	CFG	1	1	1	161 shp					147	For pressure-jet helicopter
	356-23	ACFJ	3	2	1	2 100 lb. t	0.88	6.1	22.3	47	410	
Curtiss-Wright Corp., Wright Aeronautical Div., Wood-Ridge, N. J.	J65-B-5	AFJ	13	2	1	7 200 lb. t			37.5	100	2 750	
	J65-B-7	AFJ	13	2	1	7 800 lb. t			37.5	115	2 795	
	J65-W-16, 16A	AFJ	13	2	1	7 700 lb. t			37.5	113	2 757	North American FJ-4B
	J65-W-18	AFJ	13	2	1	10 500 lb. t			37.5	181	1 485	Grumman F11F-1
Garrett Corp., AiResearch Mfg. Co., Phoenix, Ariz.	GTP30-50	CFS	1	1	1	50 shp	1.15		16	20.8	31.5	
	GTP70-50	CFS	2	1	1	100 shp	1.1		28.5	31.06	224	
	GTP85-114	CFG	2	1	1	102 shp	1.27	3.34	30.5	35.5	217	
	TSE 331-7	CFS	5	3	1	460 shp	0.68		19.5	40.5	160	Turboshaft
	GTCP85-100	CFGS	2	1	1	210 shp or 107 shp	1.11 shp 1.27 shp	3.34	28.4	32.9	284	
	GTP100-42	CFGS	3	1+1	0	415 shp	1.04	6.0	25.5	50.52	330	Also designated GTCP165-6
General Electric Co., Flight Propulsion Div., Evendale, Ohio	J47-25	AFJ	12	1	8	7 200 lb. t	1.06	5.35	36.75	145	2 554	Boeing B-47E, water/alcohol injection
	J47-27	AFJ	12	1	8	5 970 lb. t	1.06	5.35	36.75	148	2 007	Lockheed F-86F non-afterburning
	J47-33	AFJ	12	1	8	7 650 lb. t	1.15	5.35	36.75	228	3 190	Lockheed F-86D afterburner
	J73-3	AFJ	12	2	8	8 920 lb. t	0.917	7.0	36.75	147.5	3 646	Lockheed F-86H non-afterburning
	J79-2	AFJ	17	3	10	16 150 lb. t.	2.0	12	38.31	204	3 620	McDonnell F4H-1, North American A3J
	J79-3A	AFJ	17	3	10	14 800 lb. t	2.01	12	38.31	204	3 755	Lockheed F-104A, B, C, D, Regulus II
	J79-5A	AFJ	17	3	10	15 600 lb. t.	2.02	12	38.31	204	3 570	Convair B-58
	J79-7	AFJ	17	3	10	15 800 lb. t	1.97	12	38.31	204	3 475	CF-104, F104C, D, F11F-1F
	J79-8	AFJ	17	3	10	17 000 lb. t	1.93	12	38.31	204	3 200	McDonnell F4H-1, North American A3J
	J79-11A	AFJ	17	3	10	15 800 lb. t.	1.97	12	38.31	204	3 485	Lockheed F-104G
	J93-3	AFJ	17	3	10	30 000 lb. t						North American B-70
	X353-5	AFLF	8	2	1	2 580 lb. (horiz.) 7 170 lb. (vert.)	0.98 0.34	7.0 1.1	76 72	90	1 145	Ryan VZ-11
	CJ-805-3	AFJ	17	3	10	11 200 lb. t	0.805	13	32	189	2 800	Convair 880, length w/ rev/suppressor
	CJ-805-3B	AFJ	17	3	10	11 650 lb. t	0.806	13	32	189	2 815	Convair 880M, length w/ rev/suppressor
	CJ-805-23	AFF	17	2	10	16 100 lb. t	0.573	13	31/53	130	3 740	Aft Fan Convair 990 with reverser
	CJ-805-23C	AFF	17	2	10	16 100 lb. t.	0.575	13	32/53	105	3 470	Aft Fan Caravelle 10A with reverser
Lynn, Mass.	T58-6	AFS	10	2+1	1	1 050 shp.	0.64	8.3	16	55	271	HU2K, HSS-2, YHC-1A, M274 (VTOL), K-16 (VTOL)
	T58-8	AFS	10	2+1	1	1 250 shp.	0.61	8.3	16	60	289	HSS-1, HRB-1, HU2K, HU25
	CT58-110	AFS	10	2+1	1	1 750 shp.	0.61	8.3	16	55	304	Vertol 107, S-61, S-62
	J85-5	AFJ	8	2	1	3 850 lb. t	2.20	7.1	20.2	108.8	555	Northrop T38A, N156F, Q4B
	J85-7	AFJ	8	2	1	2 400 lb. t	0.975	7.1	17.8	39.2	327.4	McDonnell GAM-72 Quail
	CJ610-1	AFJ	8	2	1	2 850 lb. t	0.99	7.1	17.7	40.5	335	Aero Commander 1121, Piaggio-Douglas PD-808
	CJ610-2B	AFJ	8	2	1	2 400 lb. t	0.81	7.1	17.7	40.5	335	Swiss American SAAC-23
	CF700-2B	AFF	8	5	1	4 200 lb. t	0.686	7.1	34.5	64.7	640	Aft turbofan
	T64-2	AFS	14	2+2	1	2 810 shp	0.492	13.8	30	81	504	
	T64-4	AFS	14	2+2	1	2 850 shp.	0.490	12.6	35	113	1 130	de Havilland Caribou Testbed
	T64-6	AFS	14	2+2	1	2 850 shp.	0.495	12.5	30	83	713	Vought Tri-service VTOL transport
	T64-8	AFS	14	2+2	1	2 850 shp.	0.490	12.6	45	113	1 130	
General Motors Corp., Allison Div., Indianapolis, Ind.	T56-A-1	AFP	14	4	6	2 750 shp	0.54	9.25	40	145	1 660	Lockheed C-130A
	T56-A-7	AFP	14	4	6	4 050 shp						Lockheed C-130B
	T56-A-8	AFP	14	4	6	4 050 shp.						Grumman W2F-1
	T56-A-9	AFP	14	4	6	3 750 shp						Lockheed C-130A, GV-1
	T56-A-10W	AFP	14	4	6	4 535 shp						Water alcohol injection P3V-1
	501-D13	AFP	14	4	6	3 750 shp	0.54	9.25	45	145	1 645	Lockheed Electra
	T63-A1	ACFS	7, 1		1	250 hp	0.75		34.0	34.5	128	Light fixed wing aircraft
	T63-A3, A5	ACFPS	7, 1		1	250 shp.	0.70		18.5	36.5	147	Max. width 18.8, Army light obs. helos.
Solar, San Diego, Calif.	T62	CFS	1	1	1	80 shp	1.16	3.42	15.5	24.7	81	Single shaft, constant speed APU

Legend:

* —Approximate
shp —shaft horsepower
lb. t. —pounds thrust
‡ —Basic engine
§ —All fan
† —Weight includes oil cooler

Manufacturer and Address	Designation	Type**	No. of compressor stages axial centrifugal	No. of turbine stages	No. of combustors	Max. power at S. L.	Specific fuel consumption at max. power lb./hr./lb. t. or shp.	Compression ratio at max. rpm	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
United Aircraft Corp., Pratt & Whitney Div., E. Hartford, Conn.	JT3C-6	AFJ	16	3	8	13 500 lb. t	0.775	12	38.88		4 234	Boeing 707-120, DC-8
	JT3C-7	AFJ	16	3	8	12 000 lb. t	0.785	12	38.88		3 495	Boeing 720
	JT3C-12	AFJ	16	3	8	13 000 lb. t	0.82	13	38.88		3 550	Boeing 735
	JT3D-1	AFF	15	4	8	17 000 lb. t.	0.52	13	53		4 090	Boeing 707-120B, DC-8
	JT3D-3	AFF	15	4	8	18 000 lb. t.	0.515	13	53		4 170	Douglas DC-8
	JT3D-8A	AFF	15	4	8	21 000 lb. t	0.606	16	53		4 160	Boeing 707-320B
	JT4A-9, 10	AFJ	15	3	8	16 800 lb. t.	0.80	17	43	144.1	5 050	—10 weight 4,845 lb. Douglas DC-8
	JT4A-11, 12	AFJ	15	3	8	17 500 lb. t	0.81	17	43		5 100	—12 weight 4,895 lb. Boeing 707-320.
	JT8D-1	AFF	13	4	9	14 000 lb. t	0.61		44		2 991	Boeing 727
	JTF10A	AFF	16	4	0	10 500 lb. t	0.585	15			2 120	Short-range civil jet, Caravelle 10-B
	JTFD12A-1	AFF	9	2	8	4 050 shp.		6.5			870	Sikorsky S-64
	JTFD12A-2	AFF	9	4	8	4 050 shp.	0.60	6.5			870	Free turbine shaft drive.
	JT12A-5	AFJ	9	2	8	3 000 lb. t	0.90	6.0	21.0	70	436	Lockheed JetStar
	JT12A-6	AFJ	9	2	8	3 300 lb. t.	0.985	6.5			400	JT12A-6, T-39, C-140A
	JT12A-21	AFJ	9	2	8	4 025 lb. t.	2.43	6.5	21.0		551	Afterburner T-39, C-140A
	TF33-P-3	AFF	15	4	8	17 000 lb. t	0.52	13	53		3 900	B-52H
	TF33-P-5	AFF	15	4	8	18 000 lb. t	0.535	13	53		4 278	JT3D-3A.
	TF33-P-7	AFF	15	4	8	21 000 lb. t	0.606	16	53		4 490	JT3D-8A, C-141
	J57-P-8	AFJ	16	2	8	9 500 lb. t	0.82	13	39.13	108.07	2 900	Douglas A4D-5.
	J57-P-20	AFJ	16	3	8	18 000 lb. t.	2.35	13	39.0	243	4 750	JT3C-26, F8U-2N
	J57-P-19W, D	AFJ	16	3	8	13 750 lb. t	0.80	13	39.0	167.33	3 870	JT3C-2, B-52, F&G, F100, 101, 102
	J58	AFJ				30 000+ lb. t						JT11
	J60-P-3	AFJ	9	2	8	3 000 lb. t	0.59	6.5	21.5	78	436	North American T-39
	J60-P-1	AFJ	9	2	8	3 000 lb. t	0.985	6.5	21.5	78	435	JT12A-7, Sikorsky S-60
	J75-P-19W	AFJ	15	3	8	26 500 lb. t	2.20	12	43	259.3	5 960	Afterburner water inj., JT4A-29. Republic F-105D
	PT6A-1	ACFP	4	2	1	500 shp.	0.70	6	18.45	52	250	
	PT6B-2	ACFS	4	2	1	500 shp.		6	18.45	48.5	265	

U.S. Drones

Manufacturer	Military designation	Mission	Agency	Overall length, less booster ft.	Overall span wings or fins, ft.	Body diameter ft.	Launch weight less booster lb.	Powerplant: No. of Eng., Manufacturer, Eng. designation, Rated thrust-lbs.	Guidance: Manufacturer	Guidance: Type	Performance: Speed mph	Performance: Endurance, min	Remarks
[illegible]	SD-5	Multi	Army	18	17'		1 100	1 Lyc. IMO-360 B1B @ 225 hp.	ITT	Radio-Command	345	45	2 Jato boosters
	1025	Target	Army	15' 1"	12' 11"			1 McCulloch @ 125 hp.			340	60	
	PD75-4-1	Target		15' 1"	12' 11"			1 Con. TS10-200 @ 115 hp.					
	XKD2B-1/Q-12	Trans.	Navy/USAF	13' 4"	3' 3"		560	1 lpr					
Del Mar Engineering Laboratories, Del Mar, Calif.	DH-1B Whirlymite	Recon		15' 3"			400	1 Kiekhaefer Mercury 900 @ 56 hp			74		Helicopter drone
	DH-2B Whirlymite	Recon		18' 3"			345	1 Solar Titan T62-T-15 @ 85 hp.			77		Helicopter drone
Fairchild Stratos Corp., Aircraft-Missiles Div., Hagerstown, Md.	AN/USD-5	Surv.*	Army	32' 0"	24' 8"		6 500	1 P&W J60-P2 @ 2,900 lb. t + rkt booster @ 40,000 lb. t	Minn. H'well	Inertial			*Surveillance
[illegible] Co., [illegible] N. Y.	DSN-1	Anti-Sub.	Navy					1 Porsche @ 72 hp.		Radio-Command			Destroyer carried Navy's DASH Program
	DSN-2	Anti-Sub.	Navy					2 Porsche @ 75 hp					
	DSN-3	Anti-Sub.	Navy					1 Boeing T50-BO-4 @ 270 shp.		Radar Sonar			
Ling-Temco-Vought, Dallas, Tex.	KD2U-1 Regulus II	Target	Army	57	20	0		1 GE J79 with Aft. burner + Aerojet 115,000 lb. boost					
Lockheed Aircraft Corp., Burbank, Calif.	QB-47	Target	USAF	100' 10"	116'			6 GE J47-GE-25 @ 6,000 lb. t		Radio-Command	495		Boeing airframe
	QF-104	Target	USAF	54' 9"	21' 11"			1 GE J79-3A @ 14,800 lb. t.		Radio-Command			
North American Aviation, Inc., Los Angeles, Calif.	NA 273	Tran	Army	16	9	1	427	1 Marquardt Ramjet + NAA Rocketdyne Booster @ 5,500 lb. t.	NAA Columbus	Radio-Command	M 2		Redhead "roadrunner" recoverable
[illegible] Corp., Ventura Division, Van Nuys, Calif.	DQ-10	Target	Army	12' 3"	11' 6"		305.6	1 McCulloch O100-1 @ 77 hp.	Babcock Eng'g.	Radio-Command	222	60	DQ-10B, D-Army & USAF, KD2R-5-Navy
	RP-75	Target	Army	9' 8"	5'	1'	301	2 spc. Assoc. I hsm @ 30 lb. t., RPC @ 100 lb. t.	Northrop		M .90	23	RP-78—Navy & USAF
	SD-1	Surv.*	Army	12' 5"	11' 6"		430	1 McCulloch	Babcock Eng'g.			40	*Surveillance
Ryan Aeronautical Co., Aerospace Div., San Diego, Calif.	KDA-1 Firebee	Target	Navy	17' 4"	11' 3"		1 845	1 Fairchild J44-R-20 @ 1,000 lb. t			530	60	
	KDA-4 Firebee	Target	Navy	17' 4"	11' 2"		1 845	1 Fairchild J44-R-20 @ 1,000 lb. t.			630	60	
	Q-2A Firebee	Target	USAF	17' 4"	11' 3"		1 800	1 Con. J69-T-19 @ 1,000 lb. t			430	60	
	XQ-2C Firebee	Target	USAF	22' 11"	12' 11"	3' 0"	2 500	1 Con. J69-T-29 @ 1,700 lb. t.	Lear	Radio/Radar	M .90	60	
	Q-2C Firebee	Target	Army	22' 11"	12' 11"	3' 0"	2 500	1 Con. J69-T-29 @ 1,700 lb. t.	Lear	Radio/Radar	M .55	60	Also used by USAF and Navy

U. S. Reciprocating Engines

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Power Ratings: Max. takeoff power (hp) SL	At rpm	Normal rated power (hp)	At rpm	At altitude (ft.)	Fuel grade	Diameter or dimensions in. (without cowling)	Blower ratio	Gross weight dry (lb.)
Avco Corp., Lycoming Div. *Williamsport, Pa.*	O-235-C1B	4	Ho	Direct	115	2,800	108	2,600	S.L.	80	22.50x32		210
	O-290-D2C	4	Ho	Direct	140	2,800	135	2,600	S.L.	80/87	22.5x22.21		261
	O-320-A2C	4	Ho	Direct	150	2,700	150	2,700	S.L.	80/87	23.12x32.21		271
	O-320-B2C	4	Ho	Direct	160	2,700	160	2,700	S.L.	91/96	23.12x32.21		277
	IO-320-A1A	4	Ho	Direct	150	2,700	145	2,700	S.L.	80/87	19.30x32.21		273
	O-360-A1D	4	Ho	Direct	180	2,700	180	2,700	S.L.	91/96	24.72x33.37		281
	O-360-C2D	4	Ho	Direct	180	2,700	180	2,700	S.L.	91/96	19.58x33.37		288
	VO-360-A1B	4	Vo	Direct	180	2,900	180	2,900	S.L.	91/96	21.42x33.37		293
	HO-360-B1A	4	Ho	Direct	180	2,700	180	2,700	S.L.	91/96	22.17x33.37		281
	AIO-360-B1B	4	Ho	Direct	225	3,180	225	3,100	S.L.	100/130	17.17x33.37		271
	IO-435-A1F	6	Ho	Direct	260	3,400	250	3,200	S.L.	80/87	34.73x33.58		351
	VO-435-A1F	6	Vo	Direct	260	3,400	250	3,200	S.L.	80/87	21.11x33.58		240
	GO-435-C2B2-6	6	Ho	Gear	260	3,400	215	3,100	S.L.	80/87	28.02x33.12		430
	TVO-435-A1A	6	Vo	Direct	260	3,200	220	3,200	26,500	100/130	36.51x33.57		458
	GO-480-B1D	6	Ho	Gear	270	3,400	260	3,000	S.L.	80/87	23.02x33.12		432
	GO-480-C1F6	6	Ho	Gear	295	3,400	280	3,000	S.L.	100/130	27.40x33.12		437
	GSO-480-B1B6	6	Ho	Gear	340	3,400	320	3,200	7,000	100/130	33.20x33.12		500
	IGSO-480-A1B6	6	Ho	Gear	340	3,400	320	3,200	11,500	100/130	23.20x33.12		497
	O-540-B1A5	6	Ho	Direct	235	2,575	235	2,575	S.L.	80/87	21.46x33.37		365
	O-540-E1B5	6	Ho	Direct	260	2,800	235	2,400	S.L.	91/96	21.50x33.37		398
	O-540-A1D5	6	Ho	Direct	250	2,575	250	2,575	S.L.	91/96	21.50x38.12		397
	VO-540-B1B	6	Vo	Direct	305	3,200	305	3,200	S.L.	80/87	21.57x31.11		429
	TIO-540-C1A	6	Ho	Direct	305	3,200	305	3,200	S.L.	80/87	24.55x34.70		425
	IO-540-A1A5	6	Ho	Direct	290	2,575	290	2,575	S.L.	100/130	19.92x34.25		441
	IO-540-B1A5	6	Ho	Direct	290	2,575	290	2,575	S.L.	100/130	18.60x31.25		437
	IO-540-E1A5	6	Ho	Direct	290	2,575	290	2,575	S.L.	91/96	22.21x32.37		453
	IGO-540-B1A	6	Ho	Gear	350	3,400	325	3,000	S.L.	100/130	21.46x31.25		504
	IGSO-540-B1A	6	Ho	Gear	380	3,400	300	3,200	11,500	100/130	20.20x31.25		512
	TVO-540-A1A	6	Vo	Direct	305	3,200	305	3,200	17,000	100/130	36.00x31.70		510
	IO-720-A1A	8	Ho	Direct	380	2,175	380	2,175	S.L.	100/130	16.7x41.2		560
Continental Motors Corp. *Muskegon, Mich.*	A-65-8F	4	Ho	Direct	65	2,300	65	2,300	S.L.	80/87	31.0x31.38		170
	C-85-12F	4	Ho	Direct	85	2,575	85	2,575	S.L.	80/87	31.25x31.38		184
	C-90-12F	4	Ho	Direct	90	2,475	90	2,475	S.L.	80/87	31.46x31.56		188
	E-185-9	6	Ho	Direct	205	2,600	185	2,300	S.L.	80/87	47.62x33.21		362
	O-200-A	4	Ho	Direct	100	2,750	100	2,750	S.L.	80/87	28.53x31.56		190
	E-225-8	6	Ho	Direct	225	2,650	185	2,400	S.L.	80/87	17.62x33.31		355
	O-300-A,-B,-C,-D	6	Ho	Direct	145	2,700	145	2,700	S.L.	80/87	38.19x31.50		268
	GO-300-A,-B,-C,-D	6	Ho	Gear	175	3,200	175	3,200	S.L.	80/87	39.42x31.50		314
	IO-470-H	6	Ho	Direct	225	2,600			S.L.	91/96			415
	O-470-10	6	Ho	Direct	213	2,600			S.L.	80/87			405
	O-470-J	6	Ho	Direct	225	2,550	225	2,550	S.L.	80/87	36.03x33.32		371
	O-470-K, L	6	Ho	Direct	230	2,600	230	2,600	S.L.	80/87	36.03x33.56		401
	O-470-G, M, M5	6	Ho	Direct	240	2,600	215	2,600	S.L.	91/96	37.65x33.56		410
	IO-470-J, K	6	Ho	Direct	225	2,600	225	2,600	S.L.	80/87	37.15x33.56		394
	IO-470-E,-G,-P,-R	6	Ho	Direct	260	2,600	260	2,600	S.L.	91/96	37.13x33.56		432
	IO-470-D, E, F, H, L, M, N	6	Ho	Direct	260	2,625	260	2,625	S.L.	100/130	43.31x33.56		426
	TSIO-470-B	6	Ho	Direct	260	2,600	260	2,600	16,000	100/130	42.82x33.56		427
	FSO-526-A	6	Ho	Direct	270	3,200	270	3,200	[illegible]	91/96	50.33x38.64	10.04	553
Franklin Engine Co., Inc. *Syracuse, N. Y.*	4A4-100-B3	4	Ho	Direct	100	2,550				80			200
	6A4-150-B3	6	Ho	Direct	150	2,600				80			258
	6A4-165-B3	6	Ho	Direct	165	2,800				80			278
	6AG4-185-B12	6	Ho	G .632:1	185	3,100				80			282
	6A4-200-C6	6	Ho	Direct	200	3,100				91			307
	6V4-200-C32, C33 O-335-4,-6	6	Vo	Direct	200	3,100				91			297
	6VS-215-B13F O-125-1	6	Vo	Direct	215	3,200				80			372
	6V-335-A, -B	6	Vo	Direct	210	3,100				91			295
	6VS-335	6	Vo	Direct									
Pratt & Whitney Aircraft Div., United Aircraft Corp. *East Hartford, Conn.*	R2000-D6	14	Rad	G .500	1,450	2,700	1,200	2,550	6,400	100/130	49.10	7.15	1,585
	R2000-2SD13-G	14	Rad	G .500	1,450	2,700	1,200	2,550	5,000	100/130	49.10	7.15:8.52	1,600
	R2800-CB3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	108/135	52.80	7.29	2,357
	R2800-CB4	18	Rad	G .450:1	2,500	2,800	1,800	2,600	6,500	108/135	52.80	7.29	2,357
	R2800-CB16	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	7.29:8.58	2,381
	R2800-CB17	18	Rad	G .450:1	2,500	2,800	1,800	2,600	5,500	108/135	52.80	7.29:8.58	2,381
	R2800-C[illegible]	18	Rad	G .450:1	2,500	2,800	1,800	2,600	7,500	115/145	52.80	7.29	[illegible]
	R2800-CB5,-54	18	Rad	Direct	2,100	2,700	1,800	2,600	7,000	115/145	52.80	7.29	2,331
	R2800-CB15,-99W	18	Rad	G .450:1	2,500	2,800	1,800	2,600	[illegible]	115/145	52.60	7.60:8.50	2,380
Wright Aeronautical, Curtiss-Wright Corp. *Wood Ridge, N. J.*	[illegible]18BD1 / R3350-75	18	Rad	G .4375:1	2,200	2,800	2,100	2,400	1,160	100/130	55.62	6.46	2,015
	[illegible]HD315 / R1820-76A/76B	9	Rad	G .666:1	1,425	2,700	1,2[illegible]	2,500	3,500	100/130	55.27	7.21	1,190
	[illegible]18[illegible]12 / R3350-26W	18	Rad	G .4375:1	2,700	2,900	2,400	2,600	8,200	115/145	55.6	6.46	2,853
	[illegible]7BA1 / R1300-1A	7	Rad	G .5625:1	800	2,600	700	2,400	5,000	91/98	50.45	7.21	1,065
	[illegible]18[illegible]B1,2,3	18	Rad	G .4375:1	3,400	2,900	2,600	2,600	6,600	115/145	56.6	6.46	2,850
	865[illegible]9HD1 / R1820-103	9	Rad	Direct	1,425	2,700	1,275	2,500	3,800	100/130	54.25	7.21	[illegible]
	956[illegible]7BA1 / R1300-2B	7	Rad	Direct	800	2,600	700	2,400	5,000	91/98	50.45	7.21	1,067
	[illegible]9HF1,2 / R1820-82-82A	9	Rad	G .5625:1	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	[illegible]
	[illegible]7BA1 / R1300-3	7	Rad	Direct	800	2,600	700	2,400	5,000	91/98	50.45	7.21	[illegible]
	972TC18DA1 / R3350-34	18	Rad	G .4375:1	3,250	2,900	2,600	2,600	5,500	115/145	56.6	6.46	3,411
	[illegible]TC18EA12 / R3350-32W,-32WA	18	Rad	G .4375:1	3,700	2,900	2,800	2,600	4,100	115/145	56.6	6.46	3,580
	995[illegible]9HF1,2,3 / R1820-84,84A,84B	9	Rad	Direct	1,525	2,800	1,275	2,500	2,500	115/145	55.74	7.21	1,418
	98C9HD1 / R1820-86	9	Rad	G .666:1	1,425	2,700	1,275	2,500	3,100	100/130	55.27	7.21	1,385
	98C9HF1 / R1820-88	9	Rad	G .5625:1	1,525	2,800	1,275	2,500	2,500	115/145	55.74	7.21	[illegible]
	R1820-90-9A	9	Rad	G .5625:1	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,420
	972TC18DA1 / R3350-91	18	Rad	G .4375:1	3,250	2,900	2,600	2,400	8,500	115/145	56.6	6.46	3,162
	[illegible]TC18EA1 / R3350-38	18	Rad	G .355:1	3,400	2,900	2,800	2,650	4,500	115/145	56.6	6.46	[illegible]
	[illegible]9HE1 / R1820-82WA	9	Rad	Direct	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	[illegible]
	[illegible]7BA1	7	Rad	G .5625:1	800	2,600	700	2,400	7,100	91/98	50.40	7.21	[illegible]
	[illegible]9HF1,2	9	Rad	G .5625:1	1,475	2,800	1,275	2,500	4,500	100/130	54.95	7.21	[illegible]
	972TC18DI 2	18	Rad	G .4375:1	3,250	2,900	2,600	2,600	6,500	115/145	56.6	6.46	[illegible]
	[illegible]TC18[illegible]1	18	Rad	G .437:1	2,800	2,800	2,100	2,600	1,300	115/145	56.6	6.46	[illegible]
	[illegible]TC18EA1 / R3350-42	9	Rad	Direct	1,525	2,800	1,275	2,500	1,900	115/145	55.74	7.21	[illegible]
	981TC18EA1	18	Rad	G .4375:1	3,400	2,900	2,800	2,600	5,500	115/145	56.6		[illegible]
		9	Rad	Direct	1,525	2,800	1,275	2,500	3,800	115/145	55.74	7.21	[illegible]
	988TC18EA1	18	Rad	G .666:1	1,425	2,700	1,275	2,500	3,100	100/130	44.35	3.16	[illegible]
	988TC18EA2	18	Rad	G .4375:1	3,400	2,900	2,800	2,600	4,700	115/145	56.59	6.46	3,645

G—Geared
Ho—Horizontally opposed
Rad—Radial
S.L.—Sea level
Vo—Vertically opposed
[1] For helicopter installation
Extended propeller shaft
[2] Engine has a 42-lb. turbocharger that is mounted separate

U.S. Personal and Business Aircraft

Manufacturer and Address	Designation	Basic Data: No. of seats	Over-all span	Over-all length	Max. height 3-pt	Gross wing area, sq. ft.	Weight empty lb.	Normal gross wt. lb.	Powerplants: Number, make, model and max. rating ea.	Performance: Normal fuel capacity gal	Max. speed mph	Landing speed mph	FAA field length takeoff ft.	FAA field length landing ft.	Max. range mi.	Price, FAF $
Aerocar International Corp. *Ft. Worth, Texas*	Aerocar Model I	2	34'	21' 6"	7' 0"	190	1,500	2,100	Lyc. O-320 @ 143 hp; Lyc. O-360 @ 185 hp	18	117	50	650	550	500	12,000
	Aerocar Model II	4	34'	22' 4"	8'	190	1,200	2,200	Lyc. O-320 @ 142 hp; Lyc. O-360 @ 180 hp	38	135	50	1,300	1,000	600	12,500
Aero Commander, Inc. *Bethany, Okla.*	Aero Commander 500A	7	49' ½"	35' 1"	14' 6"	255	4,300	6,250	2 Con. IO-470M @ 260 hp	156	228	79	1,200	1,150	1,250	87,500
	Aero Commander 500B	7	49' ½"	35' 1"	14' 6"	255	4,328	6,750	2 Lyc. IO-540-B1A5 @ 290 hp	156	228	75	1,390	1,290	1,125	81,500
	Aero Commander 560F	7	49' ½"	35' 1"	14' 6"	255	4,700	7,500	2 Lyc. IGO-540-B1A @ 350 hp	223	218	85	1,150	1,300	1,541	97,500
	Aero Commander 680F	7	49' ½"	35' 1"	14' 6"	255	4,800	8,000	2 Lyc. IGSO-540-B1A @ 380 hp	223	262	90	1,380	1,350	1,151	113,500
	Jet Commander	1-6	43' 1"	43'	15' 10"	263	6,115	11,000	2 GE CJ610 @ 2,850 lb. t.	225	555	96	2,276	2,210	1,577	475,000
Bede Aircraft, Inc. *Springfield, Ohio*	BD-2		37' 0"	22' 7"	12' 5"	150		3,100	2 Con. O-300 @ 145 hp		175					
	BD-3		38' 8"	30' 10"	12' 5"	152		3,100	2 Lyc. IO-540-B1A5 @ 290 hp	110	300					
Beech Aircraft Corp. *Wichita, Kansas*	Super 18 (G18S)	7-9	49' 8"	35' 2½"	9' 8"	360.7	5,910	9,700	2 P&W R985 AN-14B @ 450 hp	278	232	84	1,090	1,850	1,585	132,300
	Queen Air (65)	6-8	45' 10½"	33' 4"	14' 2"	277.1	4,613	7,700	2 Lyc. IGSO-480-A1B6 @ 340 hp	180	239	80	1,560	1,685	1,225	126,000
	Twin Bonanza (J50)	6	45' 11½"	31' 6½"	11' 4"	277.1	4,160	7,300	2 Lyc. IGSO-480-A1B6 @ 340 hp	180	233	82.5	1,150	1,810	1,650	109,000
	Twin Bonanza (D50E)	6	45' 11½"	31' 6½"	11' 4"	277.1	4,100	6,300	2 Lyc. GO-480-G2F6 @ 295 hp	114	211	71	1,260	1,350	1,650	87,250
	Baron (55)	4-5	37' 10"	28' 0"	9' 7"	199.2	2,900	4,880	2 Con. IO-470-L @ 260 hp	112	235	79	1,245	1,170	1,225	57,950
	Travel Air (B95A)	4-5	37' 10"	25' 4"	9' 6"	199.2	2,585	4,200	2 Lyc. IO-360-B1 @ 180 hp	79	210	70	1,240	1,300	1,170	49,500
	Bonanza (P35)	5	33' 5½"	25' 2"	6' 6½"	181	1,832	3,125	1 Con. IO-470-N @ 260 hp	49	205	60	850	740	1,215	26,875
	Debonair (B33)	4	32' 10"	25' 8"	8' 3"	177.6	1,715	3,000	1 Con. IO-470-K @ 225 hp	49	195	60	1,235	1,282	1,135	21,875
	Musketeer (23)	4	33'	24' 2"	7' 1"	146	1,235	2,300	1 Lyc. @ 160 hp	60	118	60	1,120		950	12,000
	Queen Air 80 (80)	6-8	45' 10½"	35' 3"	14' 8"	277.1	4,800	8,000	2 Lyc. IGSO-540-A1A @ 380 hp	180	252	80	1,440	2,590		135,000
Call Air, Inc. *Afton, Wyo.*	A5	2	35' 5"	23' 9"	7' 10"	196	1,030	2,150	1 Lyc. O-320-A1A @ 150 hp	23	104	43	620	150	320	
	A5T	2							1 Lyc. @ 150 hp	25	116	45	620		330	
	A6	2	35' 5"	24'	7' 10"	189	1,176	2,350	1 Lyc. O-360-A1A @ 180 hp	40	137	48	750	450		
	A7	2							1 Con. @ 215 hp			48				
	A7T	2					1,175		1 Con. W-670 @ 220 hp	40	120				450	
Cessna Aircraft Co. *Wichita, Kansas*	150	2	33' 0"	21' 6"	7' 10"	160	965	1,500	1 Con. O-200-A @ 100 hp	26	127	50	680	360	610	7,155
	172	4	36' 2"	26' 6"	8' 11"	175	1,200	2,250	1 Con. O-300-C @ 145 hp	42	135	52	825	400	780	8,895
	Skyhawk	4	36' 2"	26' 6"	8' 11"	175	1,330	2,250	1 Con. O-300-D @ 145 hp	42	135	52	825	500	780	11,500
	175	4	36' 2"	26' 6"	7' 6"	175	1,315	2,350	1 Con. GO-300-E @ 175 hp	52	170	50	565	350	1,215	10,425
	182	4	36' 2"	27' 1"	9'	175	1,615	2,800	1 Con. O-470-R @ 230 hp	65	167	50	625	590	1,190	15,500
	Skylane	4	36' 2"	27' 1"	9'	175	1,625	2,800	1 Con. O-470-R @ 230 hp	65	170	50	625	590	1,215	18,150
	185	6	36' 2"	25' 6"	7' 7"	175	1,520	3,200	1 Con. IO-470-F @ 260 hp	65	178	62	650	470	1,235	18,150
	210	4	36' 7"	27' 1"	9' 8"	175.6	1,730	3,000	1 Con. IO-470-S @ 260 hp	65	188	59	805	495	1,330	23,975
	310G	5	37' 0"	29' 6"	9' 11"	175	3,015	4,990	2 Con. IO-470-D @ 260 hp	102	220	71	870	610	1,300	59,950
	Skymaster	4							2 Con.							
	Skyknight	5	36'	29' 6"	10' 1"	175	3,150	4,900	2 Con. TSIO-470-B @ 260 hp	102	265	73	875	645	1,130	69,550
Champion Aircraft, Inc. *Osceola, Wisc.*	7EC Traveler	2	33' 5"	21' 5"	6' 2"	170	900	1,450	1 Con. C-90-12F @ 95 hp	25	115	38	500	350	500	
	7FC Tri-Traveler	2	33' 5"	21' 3"	7' 2"	170	930	1,450	1 Con. C-90-12F @ 95 hp	26	115	44	395	350	500	
	7GC Sky-Trac	2	33'	21' 11"	6' 2"	170	930	1,650	1 Lyc. O-290-D2B @ 140 hp	36	135	40	305	350	500	
	7HC DX'er	2	33'	21' 11"	7'	151	1,000	1,650	1 Lyc. O-290-D2B @ 115 hp	36	138	16	350	350	600	12,500
	Lancer	2	34' 3"	22' 1"	10'	170.2	1,700		2 Con. O-200 @ 100 hp	40	150	60	440		740	
Douglas Aircraft Co., Inc. *El Segundo, Calif.*	PD-808	6-15						12,000	P&W [illegible]		510					
Downer Aircraft Co. *Alexandria, Minn.*	Bellanca 260	4	34' 2"	22' 11"	6' 4"	161.5	1,600	2,700	1 Con. IO-470-F @ 260 hp	40	208	61	300	100	880	15,500
	Bellanca 260A	4	34' 2"	23' 4"	7' 6½"	161.5	1,720	3,000	1 Con. @ 260 hp	56	203	61			880	21,500
Grumman Aircraft Engr. Corp. *Bethpage, N. Y.*	159 Gulfstream	14	78' 6"	64'	22' 9"	610	20,431	33,600	2 RR RDa.7 @ 2,105 eshp	1,504	350	91	3,800	1,900	2,500	
	164 Ag-Cat	1	35' 8"	24' 1"	10' 9"	328	2,170	3,600	1 Con. W-670 @ 245 hp	34	110					13,500
Helio Aircraft Corp. *Norwood, Mass.*	H395A Courier	4	39'	31'	8' 10"	231	2,030	3,000	1 Lyc. GO-435-C2B2 @ 260 hp	60	170	30	155	155	750	33,180
	H395 Super Courier	4	39'	31'	8' 10"	231	2,037	3,000	1 Lyc. GO-480-G1D6 @ 295 hp	60	180	30	175	175	812	38,490
Lake Aircraft Corp. *Sanford, Me.*	Lake LA-4	4	38'	25'	9' 1"	170	1,575	2,400	1 Lyc. O-320 @ 160 hp	40	121	80	650	600	657	26,500
Lockheed Aircraft Corp. *Marietta, Ga.*	1329 JetStar	13	53' 8"	60' 5"	20' 5"	543	18,665	38,888	4 P&W JT12A-6 @ 3,000 lb. t.	2,000	565	120	5,000	4,300	2,650	
	Lockheed 60[1]	6	39' 1"	28' 1"	10' 9"	215	2,021	3,532	1 Con. TSIO-470B @ 260 hp		167	58	1,040	1,040	530	26,000
Meyers Aircraft Co. *Tecumseh, Mich.*	Meyers 200B	4	30' 6"	24' 5"	8' 7"	161.5	1,950	3,000	1 Con. IO-470-D @ 260 hp	14	208	62			850+	24,375
	Meyers 145T	2	30'	20' 10"	8' 2"	119	1,380	1,310	1 Con. O-145-2 @ 145 hp		161	55			350+	
Mooney Aircraft, Inc. *Kerrville, Texas*	Mark 21	4	35'	23'	8' 5"	167	1,525	2,575	1 Lyc. O-360 @ 180 hp	18	190	57			1,150	15,650
Piper Aircraft Corp. *Lock Haven, Pa.*	PA-22-108 Colt	2	30'	20'	6' 3"	147	940	1,650	1 Lyc. O-235-C1B @ 108 hp	18	120	54	900	500	213	5,895
	PA-18-150 Super Cub	2	35' 3"	22' 5"	6' 7"	178.5	930	1,750	1 Lyc. O-320 @ 150 hp	18	130	43	200	350	460	8,690
	PA-25-150 Pawnee	1	36' 2"	24'	7' 2"	183	1,200	2,300	1 Lyc. O-320-A2B @ 150 hp	38	111	45	895	145	140	15,600
	PA-25-235 Pawnee	1	36' 2"	24' 8"	7' 2"	183	1,350	2,900	1 Lyc. O-540 @ 235 hp	40	127	46	800	155	325	12,600
	PA-28-150 Cherokee	4	30'	23' 4"	7' 3"	160	1,185	2,150	1 Lyc. O-320-A2B @ 150 hp	50	130	53	880	335	790	10,990
	PA-28-160 Cherokee	4	30'	23' 3"	7' 3"	160	1,195	2,200	1 Lyc. O-320-B2B @ 160 hp @ 2700 [illegible]	50	138	53	775	550	690	11,990
	PA-24-180 Comanche	4	36'	24' 8"	7' 3"	178	1,610	2,550	1 Lyc. O-360A @ 180 hp	60	137	61	750	600	970	17,790
	PA-24-250 Comanche	4	36'	24' 11"	7' 4"	178	1,690	2,800	1 Lyc. O-540-A1A5 @ 250 hp	60	190	61	750	650	1,100	21,400
	PA-23-160 Apache H	5	37'	27' 2"	10'	204	2,230	3,800	2 Lyc. O-320-B2B @ 160 hp	72	183	55	900	670	853	[illegible]
	PA-23-250 Aztec B	5	37'		10' 3"	207	2,775	4,800	2 Lyc. O-540 @ 250 hp	144	215	62	750	900	1,400	52,990
Shinn Engineering, Inc. *Santa Ana, Calif.*	Shinn 2150-A	2	30'	21' 2"	7'	144	1,125	1,817	1 Lyc. O-320-A2B @ 150 hp	35	146	52	440	450	525	8,950
Stits Aircraft *Riverside, Calif.*	SA-4 Skycoupe	2	28' 7"	18' 2"	8' 11"	125	1,000	1,325	1 Con. A-65-8 @ 100 hp	24	131	57	1,225	1,150	488	
Transland Aircraft *Torrance, Calif.*	AG-2	2	42'	28' 8"	9' 8"	321.0	3,438	5,000	1 P&W R1340 @ 600 hp	123	123	58	1,000	350	455	

[1] Lockheed design, International construction.
[2] Joint project

Leading International Aircraft, Military and Civil

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan ft.	Overall length ft.	Max. height ft.	Wing gross area sq. ft	Weight empty lb.	Gross weight lb.	Powerplants	Max. speed, mph.
ARGENTINA Fabrica Militar de Aviones (Instit. de Aerotecnica) *Cordoba*	I.A. 35	Huanquero	Multi	3	8	64' 3"	45' 10"	15' 5"	455	7 700	13 700	2 I.A. 19 R El Indio	228
	I.A. 37		Research	1	0	35' 9"	38	11' 0"	315	9 100	8 800	1 R.R. Derwent 8	680
	I.A. 38		Cargo Transport			105	44' 3"	15'	1 431	13 700	35 200	4 I.A. 16 El Gaucho	[illegible]
	I.A. 45		Personal	1	3-4	44' 0"	29	9' 2"	205	2 425	3 379	2 Lyc. O-320	
	I.A. 46		Utility	1	2	33' 7"	31' 11"	7' 3"	104	1 313	2 291	1 Lyc. O-320	
AUSTRALIA Comm. Aircraft Corp. Pty., Ltd. *Port Melbourne*	C.A. 25	Winjeel	Trainer	3	0	38' 9"	28	9	240	3 285	4 235	1 P&W R985-AN2	137
	C.A. 27	Sabre Mk. 32	Fighter	1	0	37' 1"	37' 6"	14' 6"	302	11 000	20 000	1 R.R. Avon 20	700
	C.A. 28	Ceres	Agricultural	1	0	47'	30' 3"	9'	312	4 090	7 040	1 P&W Wasp S3H1-G	140
BELGIUM Avions Fairey S.A. *Gosselies*	T66 Mk. 5	Tipsy Nipper	Sport Training	1	0	19' 8"	15	6' 1"	80.7	412	660	1 Stark "Stamo" 1400A	107
	1150†	Breguet Atlantic	ASW	12	0	124	99	36'	1 292		86 000	2 R.R. Type R Ty 20	
	F104G*	Super Starfighter	Interceptor	1	0	21' 11"	54' 9"	13' 6"				1 GE J79-GE-11A @ 14 800 lb. t.	M2+
BRAZIL Sociedade Construtora Aeronautica Neiva, Ltd. *Botucatu São Paulo*	IPD 5902		Reconnaissance	1	1	35' 2"	23'	9	180	1 100	2 460	1 Lyc. O-320	
	P-56-C	Paulistinha	Primary Trainer	1	1	35' 5"	22'	6' 2"	180	880	1 300	1 Con C-90-8F	108
CANADA Avro Aircraft Div., A.V. Roe Canada Ltd. *Toronto, Ontario*	CF-100 Mk. 5		Interceptor	2	0	60' 10"	54' 2"	14' 5"	591		33 800	2 Orenda 11	
Canadair Ltd *Montreal, Quebec*	CL-13	Sabre 6	Fighter	1	0	37' 1½"	37' 6"	14' 9"	285	10 840	15 100	1 Orenda 14	700
	CL-28	CP 107 Argus	Anti-Sub.	15	0	142' 4"	128' 3"	36' 9"	2 075	81 000	148 000	4 Wright R-3350	288
	CL-30	Silver Star	Trainer	2	0	42' 5"	37' 9"	11' 8"	238	8 440	16 800	1 R.R. Nene 10	520
	CL-41A	CT-114	Trainer	2	0	36' 6"	32'	9' 0½"	220	4 870	7 300	1 P&W JT12A-5	475
	CL-41R		Adv. Trainer	2	0	36' 6"	38' 4½"	9' 2½"	220	5 500	8 000	1 P&W JT12A-5	475
	CL-44-6	CC 106 Yukon	Transport	8	131	142' 4"	136' 8"	38' 8"	2 075	85 750	205 000	4 R.R. Tyne 12	406
	CL-44D4	Forty Four	Cargo	4	0	142' 4"	136' 8"	38' 8"	2 075	87 519	210 000	4 R.R. Tyne 12	409
	CL-66A	540	Transport	3	60	105' 4"	82' 1"	28' 1½"	920	32 400	51 200	2 Napier Eland 504A	238
	CL-66B	CC 109 Cosmopolitan	Transport	3	40	105' 4"	81' 6"	28' 1½"	920	35 200	57 500	2 Napier Eland 504A	335
	CL-90	CF 104*	Strike-Recon.	1	0	21' 11"	54' 9"	13' 6"	196	14 500	29 950	1 GE J79-OEL-7	M 2
The de Havilland Aircraft of Canada, Ltd. *Downsview, Ontario*	DHC-2	Beaver	Transport	1-2	5-6	48	30' 4"	9'	250	3 000	5 100	1 P&W R985 Wasp Jr.	163
	DHC-3	Otter	Transport	1-2	9-10	58	41' 10"	13'	375	4 431	8 000	1 P&W R1340-S1H2-G	153
	DHC-4	Caribou	Transport	2	30-32	95'	72' 7"	31' 9"	912	17 480	28 500	2 P&W R2000-7M2	214
Found Bros. Aviation Limited *Malton, Ontario*	FBA-2C		Utility	1	3	36'	26' 2"	9'	180	1 511	2 850	1 Lyc. O-540-A1D5	145
COMMUNIST CHINA Chinese State Aircraft Industry		Peking I	Transport		8	57' 4"	42' 5"					2 @ 520 hp	155
CZECHOSLOVAKIA Omnipol *Prague*	Aero 145		Taxi	1	3-4	40' 2"	25' 0"	7' 3"	184	2 116	3 527	2 Walter M-332	
	L-200A	Morava	Business	1	4	39' 5"	28' 4"	7' 4"	185.8	[illegible]	[illegible]	2 [illegible] M-337	
	L-40	Meta Sokol	Sports	1	3	32' 10"	24' 7"	8' 4"	146	[illegible]	[illegible]	1 [illegible] M-332	
	Z-226	Trener 6	Trainer	2		33' 0"	25' 7"	6' 9"	150.6	1 257	[illegible]	1 Walter M 6-III	
	Z-326	Trener Master	Trainer	1	1	34' 10"	25' 7"	6' 10"	166.3	1 464	[illegible]	1 Walter M 6-III	
FRANCE S.A. des Ateliers d'Aviation Louis Breguet *Paris*	1050	Alize	ASW	3	0	51' 2"	45' 6"	16' 4"	377	12 550	18 100	1 R.R. Dart 21	285
	763	Provence	Transport	3	107	140' 8"	94' 11"	31' 4"	[illegible]	68 150	113 500	4 P&W R2800 CA18	272
	765	Sahara	Transport	4	135	140' 8"	94' 11"	31' 4"	[illegible]	68 343	113 000	4 P&W R2800 CB16	265
	1150	Atlantic	ASW	12	0	124	99	36'	1 292		86 000	2 R.R. Type R Ty 20	
	940	Integral	STOL-Exp.	2	0	57' 5"	58' 4"		470		15 500	4 Turbo. Turmo 2	230
	941		STOL-Transport	2		75	77	29'	990	25 880	45 000	4 Turbo. Turmo 3D	266
	942		STOL Transport	2	60	76'	71	29'	990	23 900	45 000	4 Turbo. Turmo 3D	230
	945		STOL Transport	2		76	71	29'	880			4 Turbo. Turmo 3D	250
Generale Aeronautique Marcel Dassault *St. Cloud (Seine-et-Oise)*		Mirage 3C	Fighter	1	0	27	48' 10"	14' 9"	375		22 400	1 SNECMA Atar 9B + 1 Sepr 841	M2.15
		Mirage 3E	Strike Fighter	1	0		46' 10"					1 SNECMA Atar 9C + 1 Sepr 844	
		Mirage 3R	Recon. Fighter	1	0		45' 11"					1 SNECMA Atar 9C	
		Mirage 3B	Trainer	2	0		41' 10"					1 SNECMA Atar 9B	
		Mirage 3V	Recon./Strike	1	0							1 SNECMA TF 106	
		Mirage 4A	Bomber	2		38' 9"	77					2 SNECMA Atar 9D	M>2
		Spirale 3	STOL Cargo	3-?	42	72' 2"	58' 5"	22' 5"	645	14 110	27 000	2 Turbo. Turmo 3D	660
		Etendard 4	Strike Fighter	1	0	31' 6"	47' 3"	14' 1"	312		18 000	1 SNECMA Atar 8	M1.08
Hurel Dubois *Villacoublay (Seine-et-Oise)*	HD 321		Transport	3	40	148' 7½"	75' 1"	28' 7½"	1,075	24 495	41,200	2 Wright 982C9HE1	260
	HD 34		Photo	7	0	148' 7½"	77' 0"	28' 7½"	1,076	26 390	42,500	2 Wright 982C9HE2	
Societe des Avions Max Holste *Reims*	MH 1521	Broussard	Utility	1	5-8	45' 1"	28' 2"	12'	273.4	3 373	5,925	1 P&W R985	165
	MH 260	Super Broussard	Light Transport	1-2	20-30	71' 11"	57' 8"	[illegible]	588.5	[illegible]	[illegible]	2 Turbo. Bastan 3D	239
	MH 250	Major	Personal	1	7	50'	35		301	4 300	8 050	2 Con. GIO-470A	180
Morane-Saulnier *Puteaux (Seine)*	MS 733	Alcyon	Trainer	3	0	37	31' 1"	11' 4"	235	2 812	3 890	1 Potez 6 D02A	184
	MS 760	Paris I	Business	1	3	33' 3"	32' 11"	8' 7"	194	4 400	7 650	2 Turbo. Marbore 2	405
	MS 760B	Paris II	Business	1	5	33' 3"	33' 6"	7' 9"	193	4 610	[illegible]	2 Turbo. Marbore 6C	432
	MS 760B	Paris II	Trainer	2		31' 3"	33' 6"	7' 9"	193	4 524	[illegible]	2 Turbo. Marbore 6C	432
	MS 760C	Paris III	Business	1	4	33' 3"	33' 6"	7' 9"	193	4 751	8 642	2 Turbo. Marbore 6C	432
	MS 880	Rallye	Personal	1	2	31' 6"	22' 9½"	9' 5"	132	880	1 765	1 Con. O-200 A	121
	MS 885	Super Rallye	Personal	1	2	31' 6"	22' 9½"	9' 0"	132	1 106	1 910	1 Con. O-300 A or B	

† Joint project * Built under license

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan ft.	Overall length ft.	Max. height ft.	Wing gross area sq. ft	Weight empty lb.	Gross weight lb.	Powerplants	Max. speed, mph.
Nord Aviation Societe Nationale de Constructions Aeronautiques *Paris*	1500	Griffon II	Interceptor	1	0	26' 7"	47' 0"	16' 5"	318.5		14 550	1 SNECMA Atar 101E3 + 1 Nord ramjet	[illegible]
	2501	Noratlas	Transport	3	42	107	72'	19' 1"	1 083	28 000	48,100	2 SNECMA Hercules	275
	2502	Noratlas	Transport	3	40	110' 3"	72'	19' 10"	1 095	28 635	50 700	2 SNECMA Hercules 758/759 + 2 Turbo Marbore 2	
	2508	Noratlas	Transport	5	40	110' 3"	72'	19' 10"	1 095	29 000	50 700	2 P&W R2800 + 2 Turbo. Marbore 2	276
	1202		Trainer	2	0	32' 1"	26' 2½"	10' 3"	177.5	1 818	2 400	1 Potez 4 D-32	151
	1402		Liaison	1	1	31' 8"	27' 8"	10' 9"	209.8	2 023	2 876	1 Potez 4 D-30	124
	C 160†	Transall	Freighter	3-4	90	131' 3"	103' 6"	36' 7"	1 722	50 037	106 925	2 R.R. Tyne Rty 20	
Etablissements Henry Potez *Paris*	Potez 75		Attack	2	0	43	30	8' 10"		3 451	5 578	1 Potez 8 D-32	171
	CM 170	Magister	Trainer	2		37'	33	9'	186	4 218	6 878	2 Turbo. Marbore 2A	435
	CM 175	Zephyr	Trainer	2		37	33' 2"	9'	188	4 706	7 117	2 Turbo. Marbore 2B	403
	CM 191		Personal	1	3	39' 5"	32' 7"	10' 6"	203.7	4 863	8 790	2 Turbo. Marbore 5	138
	P 840		Transport		18-24	53' 10"	51' 1"	17' 10"	377	12 000	18 740	4 Turbo. Astazou 2	335
Sud Aviation *Paris*	SE 210	Caravelle	Transport	3-4	80	112' 6"	104' 10"	28' 0"	1 579	[illegible]	95 210	2 R.R. Avon 522	500
	SE 210-1	Caravelle I	Transport	2-3	80	112' 6"	105	28' 7"	1 579	58 122	95 101	2 R.R. Avon 522	495
	SE 210-3	Caravelle III	Transport	2-3	80	112' 6"	105	28' 7"	1 579	59 525	101 413	2 R.R. Avon 527	493
	SE 210-6	Caravelle VI	Transport	2-3	80	112' 6"	105	28' 7"	1 579	61 222	105 822	2 R.R. Avon 531	528
	SE 210-6R	Caravelle VIR	Transport	2-3	80	112' 6"	105	28' 7"	1 579	61 206	110 231	2 R.R. Avon 533R	528
	SE 210-10A	Caravelle XA	Transport	2-3	89	112' 6"	108' 4"	29' 6"	1 579	66 963	114 640	2 GE CJ805-23C	528
	SE 210-10B	Caravelle XB	Transport	2-3	80	112' 6"	108' 1"	29' 0"	1 579			2 P&W JT8D	
	SE 210-10C	Caravelle XC	Transport	2-3	80	112' 6"	108' 1"	30' 0"	1 571			2 R.R. Avon 533	
	SE 210-10D	Caravelle XD	Transport	2-3	89	112' 6"	108' 4"	29' 6"	1 579			2 R.R. RB 171	
		Super Caravelle	Transport		100						198 000	4 B.S. Olympus 593	M2.2
GREAT BRITAIN **BRITISH AIRCRAFT CORP. GROUP** British Aircraft Corp. *London*	BAC 111	One Eleven	Transport	2-3	80	88' 6"	93' 5"	23' 6"	980	45 880	69 300	2 R.R. Spey RB 163-1	540
	TSR 2		Strike Recon.									2 B.S. Olympus	M>2
Bristol Aircraft Ltd *Bristol*	175	Britannia 100	Transport	9	93	142' 3"	114'	37' 6"	2 075	88 000	155 000	4 B.S. Proteus 705	370
	175	Britannia 250	Transport	9	84	142' 3"	124' 3"	37' 6"	2 075	93 900	185 000	4 B.S. Proteus 765	410
	175	Britannia 300	Transport	9	132	142' 3"	124' 3"	37' 6"	2 075	92 650	180 000	4 B.S. Proteus 755	400
	175	Britannia 310	Transport	9	133	142' 3"	124' 3"	37' 6"	2 075	93 100	185 000	4 B.S. Proteus 765	410
	175	Britannia 320	Transport	9	139	142' 3"	124' 3"	37' 6"	2 075	94 500	185 000	4 B.S. Proteus 765	410
	188		Research	1		35' 1"	71	13' 4"				2 DH Gyron Jr	M>2
English Electric Aviation Ltd *London*	F 3	Lightning	AW Fighter	1	0	34' 10"	50'	19' 5"				2 R.R. Avon w. reheat	M>2
	T 4	Lightning	Trainer	2	0	34' 10"	50	19' 5"				2 R.R. Avon w. reheat	M>2
	B 6	Canberra	Bomber	3	0	64	65' 6"	15' 7"	960	24 000	56 500	2 R.R. Avon	
	PR 7	Canberra	Photo Recon.	2	0	64	66' 8"	15' 7"	960	21 700	55 000	2 R.R. Avon	M .84
	B(I) 8	Canberra	Bomber	2	0	64	65' 6"	15' 7"	960	25 200	56 250	2 R.R. Avon	
	PR 9	Canberra	Photo. Recon.	2	0	68	66' 8"	15' 7"	960			2 R.R. Avon	
Hunting Aircraft Ltd. *Bedfordshire*	P 84 3	Provost T Mk. 1	Trainer	2	0	36' 11"	32' 5"	12' 2"	211	5 150	7 110	1 Al. Leonides	201
	P 84 4	Jet Provost T Mk. 3	Trainer	2	0	36' 11"	32' 5"	10' 2"	211		7 110	1 B.S. Viper	326
Vickers-Armstrongs (Aircraft) Ltd. *Weybridge, Surrey*	700	Viscount	Transport	2-3	40-54	93' 8"	81' 10"	26' 9"	963	38 000	64 000	4 R.R. Dart Mk. 506	328
	700D	Viscount	Transport	2-3	40-63	93' 8"	81' 10"	26' 9"	963	37 070	64 000	4 R.R. Dart Mk. 510	345
	800	Viscount	Transport	2-4	52-73	93' 8"	85' 8"	26' 9"	963	39 300	64 500	4 R.R. Dart Mk. 510	340
	810	Viscount	Transport	2-3	52-73	93' 8"	85' 8"	26' 9"	963	41 565	72 500	4 R.R. Dart Mk. 525	370
	950	Vanguard Mk. 9	Transport	2-3	76-139	118'	122' 10"	34' 11"	1 529	80 311	141 000	4 R.R. Tyne Mk. 512	418
	1106	VC 10	Transport	3-5	135	140' 5"	158' 8"	39' 6"	2 800	131 230	299 000	4 R.R. Conway Mk. 540	600
		Super VC 10	Transport	3-5	180	140' 2"	171' 8"	39' 6"	2 800			4 R.R. Conway Mk. 550	600
		Scimitar F Mk. 1	Fighter	1	0	37' 2"	55' 4"	15				2 R.R. Avon 200 Series	
	674	Valiant B Mk. 1	Bomber	5	0	114' 4"	108' 3"	32' 2"	2 362	75 881	175 000	4 R.R. Avon Mk. 204	M .84
BRITISH EXECUTIVE & GENERAL AVIATION GROUP British Executive & General Aviation, Ltd *Rearsby, Leicester*	B206X		Bus./Exec.	1	5-7	38'	33' 7"	12' 1"	180	4 112	6 310	2 R.R. Continental	242
Beagle-Auster Aircraft Ltd. *Rearsby, Leicester*	A 61	Terrier	Bus./Tour	1	2-3	36	23' 3"	8' 11"	184	1 636	2 350	1 DH Gypsy Major 10	123
	A 109	Airedale	Bus./Tour	1	3	36' 4"	26' 1"	10	188	1 500	2 750	1 Lyc. O-360	148
	D Mk 11				2-3	36' 4"	23' 8"	8' 11"	198	1 300	2 350	1 R-R Continental	152
Beagle-Miles Aircraft Ltd. *Shoreham Airport, Sussex*	M 117		Bus. Exec.		2-3	37	26' 1"	7' 3"	170			1 R.R. Con. O-300A / 1 R.R. O-300	
	M 218		Sports/Touring	1	3	37	25' 3"	7' 5"	170			2 R.R. Con. O-300A / 2 R.R. Con. O-300	
HAWKER SIDDELEY GROUP Blackburn Aircraft Ltd. *Brough, Yorkshire*	C Mk 1	Beverley	Transport	4	97	162	99' 5"	38' 9"	2 916	82 100	145 000	4 Bristol Centaurus	238
	NA 39	Buccaneer	Strike	2	0	42' 4"	62' 4"	16				2 de Havilland Gyron Jr.	
	S Mk 2	Buccaneer	Strike	2	0	42' 4"	62' 4"	16				2 R.R. Spey RB 163-1	M [illegible]
The de Havilland Aircraft Co., Ltd. *Hatfield Aerodrome, Herts*	DH 104	Dove	Bus./Exec.	2	8	57	39' 3"	13' 4"	335	[illegible]	8 950	2 DH Gypsy Queen 70 Mk. 3	200+
	DH 106	Comet 4	Transport	4	60-81	114' 10"	111' 6"	29' 6"	2 121	73 500	162 000	4 R.R. Avon 29	521
	DH 106	Comet 4B	Transport	4	72-102	108'	118'	29' 6"	2 059	73 100	158 000	4 R.R. Avon 29	542
	DH 106	Comet 4C	Transport	4	72-102	114' 10"	118'	29' 6"	2 121	75 500	162 000	4 R.R. Avon 29	531
	DH 110	Sea Vixen	AW Fighter	2	0	50	53' 9½"	11				2 R.R. Avon	M>1
	DH 114	Heron	Transport	2	14-17	71' 6"	48' 6"	15' 7"	499	8 484	13 500	4 DH Gypsy Queen 30 Mk. 2	191
	DH 121	Trident	Transport	3	76-100	89' 10"	114' 9"	27	1 358	67 [illegible]	115 000	3 R.R. Spey RB 163	600+
	DH 125		Bus. Exec.	2	6-8	44	47' 5"	14	353	[illegible]	18 [illegible]	2 B.S. Viper 520	500

† Joint project * Built under license

LEADING INTERNATIONAL AIRCRAFT, MILITARY & CIVIL

• SPECIFICATIONS

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Max. height, ft.	Wing gross area, sq ft.	Weight empty, lb.	Gross weight, lb.	Powerplants	Max. speed, mph.
Folland Aircraft Ltd. *Hamble, Hampshire*	FO 141	Gnat Mk 1	Fighter	1		22' 2"	29' 8"	8' 10"	137	4 700	6 750	1 B.S. Orpheus 701	M 98
	FO 144	Gnat Trainer	Trainer	2		24'	31' 9"	10' 6"	175	5 500	7 020	1 B.S. Orpheus	M 95
Hawker Aircraft Ltd. *Kingston-on-Thames, Surrey*	P 1067	Hunter F 1	Interceptor	1	0	33' 8"	45' 10½"	13' 2"	340	13 200	21 000	1 R-R Avon Mk. 122	M>.95
	P 1099	Hunter F 6	Interceptor	1	0	33' 8"	45' 10½"	13' 2"	312	13 530	21 000	1 R-R Avon Mk. 203	M>.95
	P 1050	Hunter F.G.A. 9	Grnd. Att. Fighter	1	0	33' 8"	45' 10½"	13' 2"	349	13 7[illegible]	21 100	1 R-R Avon Mk. 207	M>.95
	P 1099	Hunter F.R. 10	Recon. Fighter	1	0	33' 8"	45' 2"	13' 2"	349	13 900	21 100	1 R-R Avon Mk. 207	M>.95
	P 1101	Hunter T 7	Op. Trainer	2	0	33' 8"	48' 10½"	13' 2"	349	13 250	21 200	1 R-R Avon Mk. 122	M>.93
	P 1101	Hunter T 56	Op. Trainer	2	0	33' 8"	48' 10½"	13' 2"	349	13 820	21 000	1 R-R Avon Mk. 207	M>.95
	P 1127	Hawker	Strike Fighter	1	0	24' 4"	41' 2"	10' 3"				1 B.S. 53 Pegasus	Transonic
A. V. Roe & Co. Ltd. *Manchester*	698	Avro Vulcan B Mk. 2	Bomber	5	0	111'	97' 1"	27' 2"				4 B.S. Olympus 201	
	696	Avro Shackleton Mk. 3	Anti-Sub	10	0	119' 10"	87' 4"	23' 4"	1 421		100 000	4 R.R Griffon 57A	304
	748 Series 1		Transport	3	40-44	98'	67'	24' 10"	795	22 614	36 800	2 R.R Dart 514	291
	748 Series 2		Transport	3	40-44	98'	67'	24' 10"	795	19 [illegible]	38 800	2 R.R Dart 531	316
Whitworth Gloster Aircraft Ltd. *[illegible]*	AW 650	Argosy Series 100	Freighter	2-3	83	115	86' 9"	27	1 458	47 121	88 000	4 R.R Dart	285
	AW 650	Argosy Series 200	Freighter	2-3	84	115	86' 9"	27	1 458	48 151	90 000	4 R.R Dart 526	300
	AW 660	Argosy	Freighter	1	77	115	86' 9"	27	1 458	56 000	97 000	4 R.R Dart	290
	AW 670	Argosy	Air Ferry	2-3	126	158	86'	27	1 458	52 500	88 000	4 R.R Dart	285
	FGA 1 Mk. 6	Sea Hawk	Fighter Bomber	1	0	39	39' 8"	8' 8"	278	11 200	15 200	1 R-R Nene	521
	FAW 7	Javelin	AW Fighter	2	0	52	56' 4"	16	930			2 B.S Sapphire 7R	
	FAW 8	Javelin	AW Fighter	2	0	52	56' 4"		930			2 B.S Sapphire 7R	
	FAW 9	Javelin	AW Fighter	2	0	52	56' 4"		930			2 B.S Sapphire 7R	
Handley Page Ltd. *Cricklewood, London*	HP 80	Victor B Mk. 1	Bomber	5	0	110'	114' 11"	28' 1½"				4 B.S. Sapphire	
	HP 80	Victor B Mk. 2	Bomber	5	0	120'	114' 11"	28' 1½"				4 R.R Conway	
	HPR 7	Dart Herald Series 100	Transport	2	38-44	94' 9½"	71' 11"	24'	886	23 000	39 000	2 R.R Dart	275
	HPR 7	Dart Herald Series 200	Transport	2	48-56	94' 9½"	75' 6"	24	886		43 000	2 R.R Dart Mk. 527	
	HP 113		Transport	2	8-12	71' 8"	71' 8"	17	775		36 900	2 B.S. Orpheus	510
	HP 115		Research	1	0	20'	50' 9"	12' 3"	432			1 B.S. Viper ASV9	
Scottish Aviation Ltd. *Prestwick Airport, Ayrshire*	CP Mk. 1	Prestwick Pioneer	Transport	1	1	49' 1"	34' 1"	10' 1"	390	1 250	5 800	1 Al. Leonides 510/7	121
	CT Mk. 1	Twin Pioneer	Transport	2	15	76' 6"	45' 3"	12' 3"	670	10 178	14,600	2 Al. Leonides 531/5	173
Short Brothers & Harland Ltd. *Queens Island, Belfast*	SC 5/10	Belfast	Strategic Trans.	4	242	158'	135' 6"	47	2 466	121 120	220 500	4 R.R Tyne TY10	360
	SC 5/20	Belfast	Tactical Trans.	4	147	158	135' 6"	47	2 466	125 000	220 500	4 R.R Tyne TY22	
	SC 5/31	Belfast	Civil Transport	1	141	158'	136' 5"	47	2 466	141 800	200 000	4 R.R Tyne TY31	400
	SC 7/1	Skyvan I	Freight & Pass.	1-2	15	61' 1"	38' 10"	15' 10"	373	5 000	9 500	2 Con. GTS 10 525	185
	SC 7/2	Skyvan II	Freight & Pass.	1-2	15	64' 1"	38' 10"	15' 10"	373	6 200	11 000	2 Turbo. Astazou 2	201
	SB 5		Research	1	0	30' 6"	46' 0"	16' 7"				1 B.S. Orpheus	
	SC 1		VTOL	1	0	23' 6"	29' 1"	10' 7"				5 R.R RB108	
INDIA													
Hindustan Aircraft Factory *Bangalore*	HF 24		Fighter									2 Orpheus 12s	M 2
	AVRO 748*		Transport	3	16-44	98	67'	24' 10"	795	22 614	38 800	2 R.R Dart 531	291
ITALY													
AERFER Industrie Meccaniche Aeronautiche Meridionali *[illegible]*		Ariete	Fighter	1	0	24' 7"	31' 8"			5 251		1 R.R Derwent + 1 R-R Soar	M 1.1
Aeronautica Macchi *[illegible]*	Lockheed 60*		Utility Transport	1	5	39'	28' 1"	10' 8"	141	2 485	3 632	1 Con. TSIO-470-B	134
	MB 326		Trainer	1	1	32' 11"	34' 8"	11' 4"	204	5 027	7 430	1 B.S. Viper 11	506
Aviamilano Costruzioni Aeronautiche *Milan*	P 19	Nibbio	Tourer	1	1	31' 2"	25' 1"	8' 1"	133	1 551	2 509	1 Lyc. O-360 A2A	205
	P 19	Scricciolo	Trainer	1	1	33' 7"	24' 1"	8' 8"	150	999	1 410	1 Con. C 90-12F	136
Costruzioni Aeronautiche Giovanni Agusta *Cascina Costa, Gallarate*	AZ 8L		Transport	2	22	93' 8"	63' 0"	21' 8"	710		21 810	4 Al. Leonides Mk. 22 (503 2)	252
	AZ-8S		Transport	2	22	93' 8"	63' 0"	21' 8"	710		23 810	4 SNECMA 128	
Fiat Divisione Aviazione *Corso G. Agnelli 200, Turin*	G 91		Fighter	1	0	28' 1"	33' 9½"	13' 1"	176.7		11 350	1 B.S. Orpheus B. Or	M>1
	G 91T		Trainer	2	0	28' 2"	38' 5"	13' 6"	176.7	7 100	11 775	1 B.S. Orpheus B. Or	640
	G 91R		Photo. Recon.	2	0	28' 1"	34' [illegible]	13' 1"	176.7			1 B.S. Orpheus B. Or	M>1
	F 86K		Fighter	1	0	37' 2"	40' 1"	15	288		18 000	1 GE J47-GE 17B	655
Piaggio & C. Societa per Azioni *[illegible]*	P 136-L1		Personal	1	4	44' 5"	35' 5"	12' 7"	270	4 120	6 000	2 Lyc. GO-480-B1A6	184
	P 136-L2		Amphibian	1	4	44' 5"	35' 5"	12' 7"	269	4 358	6 500	2 Lyc. GSO-480 A1A6	213
	P 166 D		Tourer	1	1	36' 8"	29'	8' 8"	201	2 585	3 000	1 Lyc. GO-480-B1A6	192
	P 166		Transport	1	1	36' 8"	38' 1"	16	281	5 290	1 000	2 Lyc. GSO-480 B1C6	216
	P 166-CT		Amphibian	4	7	102' 8"	08' 1"	31' 10"	1 078	32 000	53,000	2 All. 501-D13	350
	PD-808		Utility	1	6-10						12 000	2 P&W PT6	510
PROCAER *[illegible]*	F 15-B	Picchio	Personal	1	1	32	21	9'	143	925	2 470	1 Lyc. O-360-A1A	180
	F 400	Cobra	Tourer	1	2	28' 8"	25' 7"	8'	124	1 135	3,750	1 Turbo. Marbore II	360
	S 251	Antilope	Personal	1	1	31' 8"	27' 7"	9'	137	1 510	1 300	1 Turbo. Astazou	340
SIAI *[illegible]*	FN 333	Riviera	Amphibian Tourer	1	3	31	21	10' 6"	163	2 112	1 207	1 Con. IO-470-A	180
Societa per Azioni Aeromere *[illegible]*	F 8 L	Falco	Tourer	1	1	26' 3"	21' 1"	7' 11"	107.5	1 117	1 720	1 Lyc. O-320-A	208
JAPAN													
Fuji Heavy Industries Ltd. *[illegible] Chiyoda-Ku, Tokyo*	T1 1	T1F2	Trainer	2		36' 7"	39' 7"	13' 3"	239	5 055	10 700	1 Orpheus Mk. 805	560
				2		32' 9"	29' 9"	9' 8"	178	2 215	2 940	1 Con. O-470-13	188
	KM	Super Nikko	Trainer	1	4	32' 9"	26	9' 5"	177.6	2 108	3 350	1 Lyc. GSO-480-B1A6	205
	LM 1	Nikko	Trainer	1	4	32' 9"	26	9' 5"	177.6	2 161	3 327	1 Con. O-470-13A	186
			Trainer	1	1	33' 9"	24' 0"	7' 5"	171	1 558	2 340	1 Con. O-470-11	127
[illegible] Industries Reorganized Ltd. Aircraft Dept. *Chiyoda-Ku, Tokyo*	F 86F*	Sabre	Fighter-Bomber	1	0	39' 1"	37' 6"	14' 7"	313.3	11 010	20 215	1 GE J47-GE 27	680
	F-104J*	Starfighter	Fighter	1	0	21' 11"	54' 9"	13' 6"				1 GE J79-GE-7	M 2
Nihon Aeroplane Mfg. Co. Ltd. *[illegible], Minato-Ku, Tokyo*	YS-11	Rivera	Pass. Trans.	2	52-60	104'	86' 3"	30'	1 020	30 724	50 265	2 R-R Dart R. Da.-10 1 Mk. 540	
NETHERLANDS													
Royal Netherlands Aircraft Factories (Fokker) *Schiphol-Zuid, Amsterdam*	F-27	Friendship	Transport	2	40-52	95' 2"	77' 2"	27' 11"	754	22 000	40 000	2 R-R Dart R. Da. 6 Mk. 511	261
	F-27	Friendship DeLuxe	Exec. Transport	5	10	95' 2"	77' 2"	27' 11"	754	23 600	42 000	2 R-R Dart R. Da. 6 Mk. 511	261
	F-27	Freightship	Pass./Cargo	2	32-40	95' 2"	77' 2"	27' 11"	754	23 858	42 000	2 R-R Dart R. Da. 6 Mk. 511 or 2 R-R Dart R. Da. 7 Mk. 528	261
	F-27M	Troopship	Military Transport	2	45	95' 2"	75' 9"	27' 11"	754	21,366	39 000	2 R-R Dart R. Da. 6 Mk. 511 or 2 Dart 7 Mk. 528	261
	F 27-500	Long Friendship	Civil Transport	2	40-52	95' 2"	82' 1"	27' 11"	754	23 500	42 000	2 R-R Dart R. Da. 7 Mk. 528-7E	250
POLAND													
Instytut Lotnictwa (Aeronautical Institute) *Warsaw*	MD 12		Transport		20	69' 11"	51' 10"	19'	699	10 616	15 030	4 Narkiewicz WN-3	
Osrodek Konstrukcji Lotniczych *Warsaw-Okecie*	TS-11	Iskra		1-2								1 tj @ 1 200 lb. t.	
W.S.K. Wytwornia Sprzetu Komunikacyjnego *Warsaw-Okecie*	PZL 102			1	1							1 Con. C90	
	PZL 104	Wilga								0 530		1 Narkiewicz WN-6	160
SPAIN													
Aeronautica Industrial, S.A. *Plaza de las Cortes [illegible], Madrid 14*	AISA I-115		Primary Trainer	2		31' 8"	24' 1"	9' 10"	150.6	1 345	1 660	1 Enmasa Tigre G IV B	
	AISA I-11B		Touring Training	1	1	30' 7"	21' 3"	9' 9"	144	350	1 471	1 Con. C 90 12F	
	AISA AVD-12C		Liaison Touring	1	3	40' 5"	25' 5"	9' 10"	193	1 664	2 560	1 Con. O-470-A	
	AISA AVD-12		Liaison or Ambulance	1	2-3	39' 9"	25' 5"	9' 10"	193	1 576	2 425	1 Enmasa Tigre G-IV-B	
Construcciones Aeronauticas, S.A. *Calle del Rey Francisco [illegible], Madrid (8)*	C-201	Alcotan	Transport	2	10	62' 5"	45' 8"	13'	460	8 427	12 125	2 Enmasa Sirio-S2	217
	C-202B	Halcon	Bomber	2	6-8	67' 6"	55' 7"	20' 11"	263	13 384	21 275	2 Wright Cyclone R1820-5[illegible]	209
	C-207	Azor	Transport	4	30-40	91' 2"	68' 5"	25' 5"	924	23 319	36 375	2 Bristol Hercules 730	253
	C 1131	Bucker	Trainer	2		24' 2"	22' 1"	7' 4"	146	1 000	1 580	1 Enmasa Tigre G IV A	122
	C 127A*	Dornier	Liaison	1	4	39' 5"	31' 6"	11' 8"	210	0 250	3 300	1 Lyc. GO-480-B1A6	155
La Hispano Aviacion S.A. *Av. Jose Antonio [illegible], Madrid*	HA 100 F1	Triana	Adv. Trainer	2		34' 1"	29' 5"	9' 8½"	186.0	1 346	5 440	1 Wright Cyclone 957C7BA1	276
	HA 100-E1	Triana	Adv. Trainer	2		34' 1"	29' 5"	9' 8½"	186.0	4 360	5 000	1 Enma. Beta B 4	275
	HA-200-R1	Saeta	Adv. Trainer	2		34' 2"	29' 1"	10' 8"	187.2	3 800	6 000	2 Turbomeca Marbore II A	435
	HA-230		Exec. Transport	2	1-6	36' 8"	31' 8"	19'			8 378	2 Turbomeca	126
SWEDEN													
Svenska Aeroplan Aktiebolaget *Linkoping*	Saab-29F	Tunnan	Fighter	1	0	36' 1"	33' 2"	12' 3"	258	9 480	17 380	1 Sven. RM-2	650
	Saab-32A	Lansen	AW Attack	2	0	42' 8"	48' 1"	15' 3"	401	15 800	28 665	1 Sven. RM-5	705
	Saab-32B	Lansen	AW Interceptor	2	0	42' 8"	48'	15' 6"	401			1 Sven. RM-6	700+
	Saab-32C	Lansen	Photo-Recon	2	0	42' 8"	48' 1"	15' 8"		15,500	27 553	1 Sven. RM-5	700
	Saab-35A B	Draken	AW Interceptor	1	0	30' 10"	50' 1"	12' 10"	538	20 000	16-18 000	1 R-R Avon 200	
	Saab-35C	Draken	Dual contr. Trainer	2	0	30' 10"	50' 4"	12' 10"	538	20 000	18 000	1 R-R Avon 200	
	Saab-35D F	Draken	Interceptor-Attack	1	0	30' 10"	50' 1"	12' 10"	538	20 000	18 500	1 R-R Avon 300	
	Saab-35E	Draken	Reconnaissance	1	0	30' 10"	50' 1"	12' 10"	538	20 000	18 000	1 R-R Avon 200	
	Saab-91B	Safir	Trainer	2	0	34' 9"	26'	7' 2"	146	1 [illegible]	2 315	1 Lyc. O-435-A	170
	Saab-91C	Safir	Personal	1	3	34' 9"	26'	7' 2"	110	1 [illegible]	2 385	1 Lyc. O-435-A	169
	Saab-91D	Safir	Trainer	2-4	0	34' 9"	26	7' 2"	110	1 570	2 660	1 Lyc. O-360	169
	Saab-105		Trainer	2	2-3	31' 2"	34' 5"	8' 10"	175	2 000	6 600	2 Turbomeca Aubisque	500
SWITZERLAND													
Flug- & Fahrzeugwerke A.G. *Altenrhein bei Rorschach*	P-16		Ground Attack	1		36' 7"	47	11	323	16 000	25 500	1 A.S. Sa. 7	700
Pilatus Flugzeugwerke A.G. *Stans Nr. Lucerne*	P-3		Trainer	2	6	34' 1"	28' 8"	10'	177	2 447	3 120	1 Lyc. GO-435-C2A	192
	PC-6	Porter	Multi	1	6-7	49' 10"	34' 9"	10'		2 100	3 090	1 Lyc. GSO-480-A7 A6	
Swiss American Aviation Corp. *St. Gallen*	Saac 23		Transport	2	8	34' 9"	39'				13,000	2 GE CJ 610-2B (Civil J85)	600
WEST GERMANY													
Bolkow-Entwicklungen K.G. *Ottobrunn bei Munchen*	BO 207		Personal	1	3	33' 9"	27' 2"	7' 8"	145	1 670	2 640	1 Lyc. O-360	
	BO 208	Junior	Personal	1	1	24' 1"	18' 5"	6' 9"	84	750	1 270	1 Con. O-200	
Dornier-Werke G.M.B.H. *Friedrichshafen A. B.*	DO 27 Q5		Multi	2	1	39' 1"	31' 6"	9' 8"	208	2 190	1 680	1 Lyc. GO-480-B1A6	
	DO 28		Multi	2	4	45' 3"	29' 6"	10' 4"	262.3	3 750	5 335	2 Lyc. C-90/12F	
	1150†	Breguet Atlantic	ASW	12	5	121'	93'	36'	1 292		95 000	2 RR Tyne R Ty 20	
Weser Flugzeugbau G.M.B.H. *Bremen*	C-160†	Transall	Transport	2-4	93	131' 3"	106' 4"	38' 7"	1 722	56 037	105 820	2 RR Tyne R Ty 20	

† Joint project

* Built under license

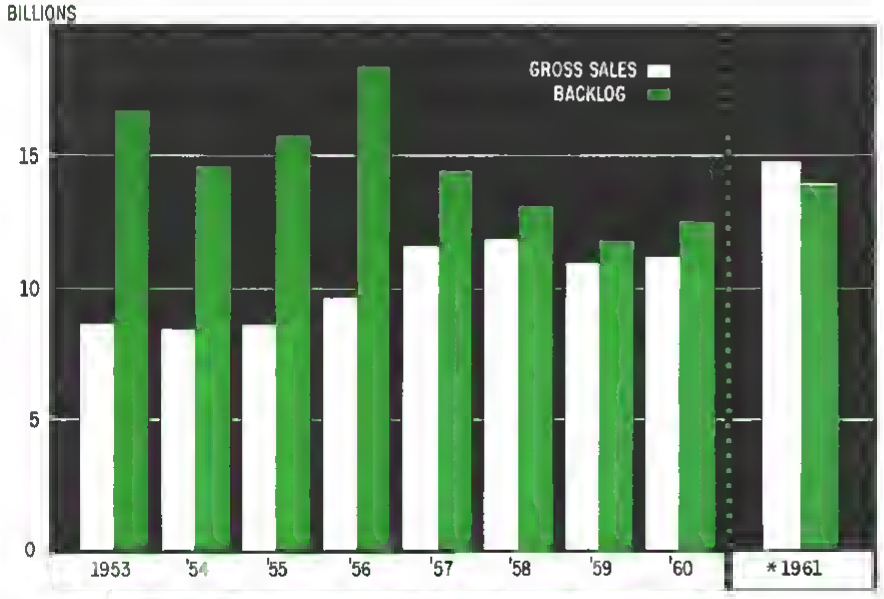
Leading International Gas Turbines

Manufacturer and Address	Designation	Type	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at maximum power	Compression ratio at max rpm.	Maximum envelope diameter in.	Maximum envelope length in.	Dry weight, less tailpipe, lb.	Remarks
CANADA Orenda Engines, Div. [illegible] Roe Canada Ltd.	Orenda 10	AFJ	10	1	6	6,355 lb. t.	1.12	5.3	42	123	2,515	
	Orenda 11	AFJ	10	2	6	7,275 lb. t.	0.95	6.1	45	131	2,425	
	Orenda 11	AFJ	10	2	6	7,275 lb. t.	0.98	6.1	45	121	2,425	
	J79-7*	AFJ	17	3	10	15,000 lb. t.		12	38.3	204	3,300+	CF 104—Built under license.
GREAT BRITAIN BRISTOL SIDDELEY GROUP [illegible] Engines Ltd.	Palouste 502*	CFJ	1C	2	A	2 lb. air sec	1.18	3.77	17.8	31.1	215	Fuel consumption based on air hp.
	Palouste 504*	CFJ	1C	2	A	2.7 lb. air sec	1.21	3.81	17.5	33.1	213.5	
	Palouste 510*	CFJ	1C	2	A	2.18 lb. air sec+100 shp.	380 lb. hr †	3.01	17.5	37.0	235	† Actual fuel consumption
	Artouste 510*	CFJ	1C	3	A	2.6 lb. air sec	320 lb./hr †	3.83	17.8	37.0	285	† Actual fuel consumption
	Artouste 600*	CFJ	1C	2	A	475 shp.	0.68	4.0	17.5	54.0	205	Length includes cone.
	Palas 600*	CFJ	1C	2	A	350 lb. t.	1.2	4.06	17.8	43.5	170	
	Nimbus	ACFJ	2A 1C	2×1	A	970 shp.	0.68	6.5	28.87	61.50	390	P 531 helicopter
	Turmo 603*	CFJ	1C	1×1	A	125 shp.	1.165	7.36	26.4	47.0	370	
Bristol Siddeley Engines Ltd.	Double Mamba 3	AFP	10	3	A	3,145 shp.	0.72	5.35	51.6	99	2,180	Gannet
	Double Mamba 8	AFD	11	3	A	3,885 shp.	0.66	5.88	50.55	103.5	2,500	Gannet
	Viper 8	AFJ	7	1	A	1,750 lb.	1.07	4.1	24.3	67	410	Provost Mk. 3
	Viper 9	AFJ	7	1	A	1,900 lb.	1.12	4.25	24.3	67	410	Uprated ASV 8, 320 prototype
	Viper 11	AFJ	7	1	A	2,500 lb.	1.07	4.31	24.55	64	545	MB 326 Macchi Jet Provost Mk. 304
	Viper 12	AFJ	7	1	A	2,700 lb.	1.10	4.12	24.55	64	540	Uprated ASV 11
	Viper 20	AFJ	8	1	A	3,000	0.985		24.55	85.30	575	D. H. 125
	Sapphire 6	AFJ	13	3	A	8,300 lb.	0.87	7.25	37.4	110	3,470	Javelin
	Sapphire 7	AFJ	13	2	A	11,000 lb.	0.88	7.40	37.55	135	3,110	Javelin Victor
	Sapphire 7R	AFJ	13	2	A	12,300 lb.	1.18	7.40	37.55	131	3,110	Limited afterburner—Javelin
	Proteus 705	ACFP	12A, 1C	2 2	8	3,900 shp.	0.82	5.93	40	109.0	2,875	Britannia 102.
	Proteus 765	ACFP	12A 1C	2 2	8	4,445 shp.	0.80	7.32	40	109.6	3,050	Britannia 250, 300, 310, 320.
	Olympus 101	AFJ	5 8	1 1	10C	11,000 lb.	0.815	9.0	40	142.7	3,670	Vulcan B Mk. 1
	Olympus 104	AFJ	7 8	1 1	10C	13,500 lb.	0.835	10.5	41.4	148.75		Vulcan B Mk. 1
	Olympus 201	AFJ	5 7	1 1	8C	17,000 lb.	0.835	10.7	41.5	155.3		Vulcan B Mk. 2
	Olympus 301					20,000			44.5	131.0		Vulcan B Mk. 2
	Orpheus 701	AFJ	7	1	7C	1,700 lb.	1.057	4.30	32.4	86.25	795	Folland Gnat.
	Orpheus 703	AFJ	7	1	7C	4,850 lb.	1.065	4.30	32.1	81.1	835	HF-24
	Orpheus 803	AFJ	7	1	7C	5,000 lb.	1.08	4.30	32.1	81.1	835	G 91 Standard VI Tsao
	Orpheus 805	AFJ	7	1	7C	[illegible] lb.	1.012	4.01	32.1	81.0	835	Fiat T1A Trainer
	Orpheus 100	AFJ	7	1	7C	4,230 lb.	0.984	4.10	32.1	85.0	800	Gnat Trainer
	Orpheus 12	AFJ	5	2	7C	6,810 lb.	0.967	5.7	32.1	95.3	1,180	
	Orpheus 12 ar	AFJ	5	2	7C	8,170 lb.	1.02	5.7	32.1	95.3	1,180	Afterburner basic thrust 6810
	BS 75	AFJ	3 10	2 2	A	7,890 lb.	0.508	13.0	36.5	92.5	1,525	Project
	BS 59 7					8,000			38.15	40.75		
	BS-53 Pegasus 3					15,000			40.25	98.8		P 1127
De Havilland Engine Co. Ltd.	Goblin 35	CFJ	1	1	16	3,500 lb. t	1.10	3.7	50	120	1,550	DH Vampire Trainer
	Gyron D GY2	AFJ	7	2	A	20,000 lb. t	1.64		55	150	1,270	
	Gyron Jr DGJ 2	AFJ				7,100 lb. t			41	81		
	Gyron Jr DGJ 10	AFJ				10,000 lb. t			40	92		Bristol T188 Supersonic Res. A/C
	Gnome H 1000	AFS	10	2 1	1	1,050 shp.	0.65	8.3	20	55	291	GET-58-6 equiv. various helicopters
	Gnome P 1050	AFP	10	2 1	1	1,000 shp.	0.60	8.3	22	76	558	Turboprop version of T58-6.
	Gnome H 1200	AFS	10	2 1	A 1	1,250	0.61	8.8	20	55	304	GET58-8 equiv. various helicopters.
	Gnome P 1200	AFP	10	3 1	A 1	1,150	0.65	8.3	32	76	595	Turboprop version of H 1200
Napier & Son Ltd. London	Eland 504	AFP	10	3	6	3,500 shp.	0.605	7	36	115.5	1,820	Convair 340, 440, 540.
	Eland 508	AFP	10	3	6	3,500 shp.	0.605	7	36	115.5	1,820	Convair 540.
	Eland N. El 3	AFPG	10 6	3	6	3,000 shp.	0.625	7	36	155.5	2,445	Rotodyne application.
	Eland N. El 7	AFPG	10 6	3	6	3,500 shp.	0.605	7	35	155.5	2,575	Rotodyne application.
	Eland E 229A	AFP	10	3	6	3,140 shp.	0.62	7	36	135	1,500	Westminster application
	Eland E 211	AFP	10	3	6	3,710 shp.	0.53	7	30	135	1,418	Westminster application
	Gazelle Mk. 161	AFP	11	2	6	1,450 shp.	0.65	5.90	18.5	70	860	Wessex 1
	Gazelle Mk. 101	AFP	11	2	6	1,650 shp.	0.65	6.25	33.5	70	870	Belvedere
	Gazelle 512	AFP	11	2	6	1,350 shp.	0.608	6.75	31	74	875	
	Gazelle 505	AFP	11	2	6	1,750 shp.	0.676	5.85	33.5	70	860	
	Gazelle 507	AFP	11	2	6	2,000 shp.	0.61	6.8	33.5	70	890	
	Industrial Gazelle	AFS	11	2	6	1,200 shp.	0.725	5.1				
	Oryx N. Or. 6	AFG	12.4	5	6	850 ghp.	0.52	6.1	19	83	315	

A—Annular
C—Cannular
shp.—Equivalent shaft horsepower
ghp—Gas horsepower
lb. t.—Pounds thrust
*—Built under license

Manufacturer and Address	Designation	Type	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at maximum power	Compression ratio at max. rpm.	Maximum envelope diameter in.	Maximum envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
[illegible] Ltd.	Avon RA 24R	AFJ	NA	NA	8	NA	NA	NA	41.5	128	NA	
	Avon RA29 1 Mks 522, 522A, 525A	AFJ	10	3	8	9,125 lb. t	0.729	9.1	36	126	3,328	
	Avon RA 29 1 Mk 524B & 525B	AFJ	16	3	8	8,765 lb. t.	0.750	8.09	36	130	3,343	
	Avon RA 29/3 Mk. 527	AFJ	16	3	8	9,500 lb t.	0.748	9.38	36	128	3,347	
	Avon RA 29/6 Mk. 531	AFJ	17	3	8	10,020 lb. t.	0.724	10.1	36	134	3,431	
	Avon RA. 29/3 Mk. 532R	AFJ	17	3	8	10,710 lb. t	0.731	10.1	36	134	3,101	
	Avon RA 29 6 Mk. 533R	AFJ	17	3	8	10,710 lb. t	0.731	10.3	36	134	3,458	
	Avon RB 146R	AFJ	NA	NA	8	NA	NA	NA	41.5	145	NA	
	Conway R. Co 17	AFF	NA	NA	10	NA	NA	NA	60	135	NA	
	Conway R. Co 12 Mks. 508 & 509	AFF	7×9	2×1	10	14,625 lb. t	0.600	11.1	12	136	4,542	
	Conway R. Co 17	AFF	NA	NA	10	NA	NA	NA	67.6	150	NA	
	Conway R. Co 43 1 Mk. 540	AFF	7×9	2×1	10	15,560 lb. t	0.603	14.8	51	154	5,000	
	Conway R. Co.43 3 Mk. 550	AFF	7×9	2×1	10	17,900 lb. t.	0.605	10.2	51	154	5,101	
	Dart R. Da. Mk 506	CFP	2	2	7	1,075 shp.	0.786	5.5	38	95	1,020	
	Dart R. Da. Mk 510	CFP	2	2	7	1,310 shp.	0.726	5.4	38	98	1,106	
	Dart R. Da. 6 Mk. 511 & 511-7E	CFP	2	2	7	1,535 shp.	0.609	5.5	38	98	1,105	
	Dart R. Da. 6 Mk. 514	CFP	2	2	7	1,535 shp.	0.500	5.5+	38	98	1,114	
	Dart R. Da. Mk 520	CFP	3	3	7	1,485 shp.	0.710	5.6	38	98	1,207	
	Dart R. Da. 7 1 Mk. 525	CFP	2	3	7	1,880 shp.	0.705	5.6	38	98	1,227	
	Dart R. Da. 7 2 Mk. 527 & 537	CFP	2	3	7	1,835 shp.	0.805	5.6	35	98	1,227	
	Dart R. Da. 7 3 Mks. 520-5 & 529-7E	CFP	3	3	7	1,835 shp.	0.665	5.6	38	98	1,223	
	Dart R. Da. 7 2 Mks. 529-7 & 529-7D	CFP	2	3	7	1,910 shp.	0.650	5.6	38	98	1,222	
	Dart R. Da. 7 2 Mks. 529-8 & 529-8E	CFP	2	3	7	1,910 shp.	0.656	5.6	38	98	1,227	
	Dart R. Da. 7 2 Mks. 530 & 531	CFP	2	3	7	1,835 shp.	0.665	5.6	38	99	1,227	
	Dart R. Da. 10 1 Mk. 512 10	CFP	2	3	7	3,305 shp.	0.650	6.35+	38	98	1,377	
	RB 168	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Dart R. Da. 7 7 Mk. 21	CFP	2	3	7	1,510 shp.	0.650	5.6	38	98	1,208	
	Dart R. Da. 8 Mk. 101	CFP	2	3	7	2,120 shp.	0.632	5.5	38	98	1,207	
	RB 108	AFJ	8	2				5.28	20.8	45.0	280	
	RB 145	AFJ	NA	NA		NA	NA	NA	22.0	50.0	NA	
	RB 162	AFJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Spey R. Sp 1 Mk. 505-5 10 & Mk. 506-14	AFF	4×12	2×2	10	9,850 lb. t.	0.545	14.1	37	110	2,200	
	Tyne R. Ty. 12 Mk. 101	AFP	6×9	3×1	10	4,985 shp.	0.455	13.5	43.2	109.7	2,210	
	Tyne R. Ty. 20 Mk. 21	AFP	6×9	3×1	10	1,080 shp.	0.446	13.5	11.2	109.7	2,203	
	Tyne R. Ty. 20 Mk. 23	AFP	6×9	3×1	10	1,840 shp.	0.416	13.5	43.3	109.7	3,218	
FRANCE [illegible]	H. S. Verdon	CFJ	1	1	8	7,[illegible] lb. t	1.10	4.8	58	104	2,072	
	H. S. Tyne	AFP	6+9	1+3	10	6,100 shp.	0.199	13.5	43.2	108.7	2,148	
C M A	Atar E5	AFJ	8	1	A	8,[illegible] lb. t	1.03	4.8	35.4	184.8	2,135	
	Atar G3	AFJ	8	1	A	8,[illegible] lb. t	2.05	4.8	35.4	236	2,710	Afterburner
	Atar 08B	AFJ	9	2	A	9,700 lb. t	0.98	5.5	35.2	153	2,203	
	Atar 09B	AFJ	9	2	A	13,230 lb. t	2.20	5.5	40	247	3,040	Afterburner
	Atar 09C	AFJ	9	2	A	13,520 lb. t	2.03	5.7	40	234	3,025	Afterburner
	Atar 09K	AFJ	9	2	A	15,135 lb. t	2.18	6.0	40	234	3,183	Afterburner
	TF 106	AFF	16	4	8	16,845 lb. t	2.25		50	187.1	3,580	Afterburner
	Artouste II	CFP	1	3	A	400 shp.	1.67	3.88	23	57	300	
	Artouste III B	ACFP	1	1	A	550 shp.	0.85	5.20	21	58	254	
	Astazou		2	2	A	540 shp.	0.62	6.0	18	55	260	
	Astazou II	AI FP	2	2	A	530 shp. + 50 lb. t.	0.59	6.0	18	57	271	
	Bastan	AI FP	2		A	1,000 shp.	0.71	5.5	42	81	168	
	Gabizo	AI FJ	1	1	A	2,420 lb. t	1.05	5.2	26	82	355	
	[illegible]	ACFJ	1	1	A	1,110 lb. t	0.99	5.0	22	60	375	
	Marboré II	CFJ	1	1	A	882 lb. t	1.08	3.85	25	52	308	
	Marboré VI	CFJ	1	1	A	1,058 lb. t	1.08	3.84	22	50	323	
	[illegible]	CFJ	1	1	A	352 lb. t	1.17	3.05	16	47	155	
	Palouste IV		1	2	A		2.11	3.80	23	47	209	
	Palouste VI		1	2	A		2.07	3.7	23	17		
	Turmo III B	CFP	2	3	A	550 shp.	0.65	5.2	21	58	254	
	Turmo III C2	CFP	2	3	A	1,300 shp.	0.62	5.8			114	
	Turmo III D2					1,330 shp.	0.61	5.8			861	
ITALY [illegible]	4092-001	CFJ	1	1	A	550 lb. t	1.25	4.0	22	41	220	Helicopter

A—Annular
C—Cannular
shp—shaft horsepower
ghp—Gas horsepower
NA—Not Applicable
lb. t.—Pounds thrust
*—Built under license



DATA FOR 1961 in this chart of Aerospace sales and backlog is based on Bureau of Census figures and is not comparable with previous years figures, which were based on previous Aerospace Industries Assn compilations. Future years will be on the new basis

Rising Budgets Intensify Cost Scrutiny

New York—Bigger Fiscal 1963 U.S. defense and space budgets channeled into program packages promise a growing, more stable market for the aerospace industry but at the same time are likely to complete and solidify the reshaping of the industry begun by advancing technology.

Industry sales volume, based on the 51 companies identified in the Securities and Exchange Commission and Federal Trade Commission survey of corporate sales and profits, is estimated at $13.5 billion for 1961. Increased government funding could lift this to $15 billion this year.

Bureau of the Census, using different data, reported 1961 aerospace industry sales at $14.8 billion—perhaps a more realistic total considering the broadening technological coverage of the industry. Industry profits, estimated on the same basis at $240 million are likely to increase only moderately, tied as they are to a 2% margin on sales. On a $15 billion sales volume, this would amount to $300 million.

Rising sales volumes, or even moderately rising profits, won't be apportioned pro rata throughout the industry. Like any bright new penny, the Administration's new funding policies, through breaking the Eisenhower constant level budget tradition, have a heads-you-win side of the coin and a tails-you-don't side.

- Successful contractors for major programs—Apollo, Saturn, the TFX, basic services fighter—can look forward to a degree of stability unusual in this industry. The losers have a problem.
- Increasing pressure on contractor performance and cost is certain to accompany increased spending.

Pressure will appear in various forms. Besides the familiar patterns of tightened procurement practices and renegotiation, which have cut profit margins in the last few years, there will be deeper forays into costs and overhead. One area which is likely to get attention: executive compensation and executive compensation plans—stock options or deferred compensation, for example.

Patents and proprietary rights, already a controversial area, are spoiling for a major eruption. Elements of both government and industry are growing more adamant in their stands.

Industry performance is in for closer scrutiny. Defense Department and the National Aeronautics and Space Administration both will stress the twin objectives of lower cost and higher reliability.

One hopeful note for improvement of industry profit margins is Defense Department's avowed interest in incentive contracts which reward quality and efficiency.

Assuming industry and government can agree on a satisfactory incentive contract system and that the renegotiation board will not later demand the incentive bonus gained by the contractor, industry may be able to break the 2% profit margin barrier.

One of the principal supporters of the incentive contract is Thomas D. Morris, assistant secretary of defense for installations and logistics. His view is that hope of increased profit is the best device to maintain increased contractor cost control, and he wants a wide range of profits attainable.

For cost-plus-incentive-fee types, he believes pretax profit margins should be allowed to range as high as the 15% maximum permitted by law, rather than the +5.9% level accepted as standard now.

Similarly, on fixed-price incentive contracts, he favors increasing the government-industry split of savings obtained from 80-20 to 75-25% or as high as 50-50.

Fixed-price contracts, which declined as a percentage of total contracts written from 70.1% in Fiscal 1952 to 46.7% in Fiscal 1961 as research and development type programs grew at the expense of assembly-line type production programs, have been considered by the government as the best way to control total price. Cost-plus contracts conversely seemed to provide best control of profit level.

The shift in DOD interest to incentive contracts appears to reflect the trend of focusing government monitor and review harder on cost elements—especially allowability—than on profits, where the squeeze has reached the point of diminishing returns.

Even renegotiation appeals are as much a matter of principle as dollars to a contractor. Boeing Co., which lost an appeal on a refund of $13 million in profits earned in 1952, would actually refund about $900,000 after tax adjustments (AW Jan. 22, p. 32).

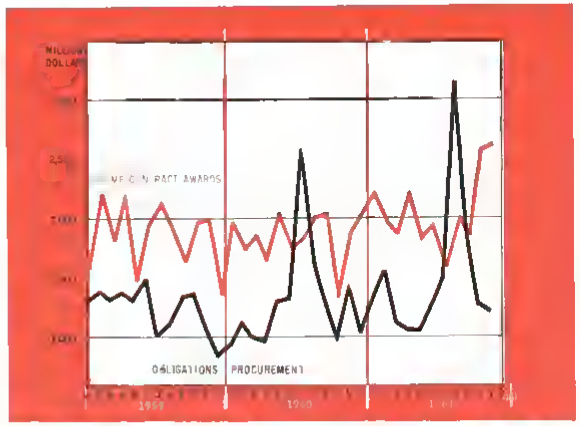
Probable Investigation

There is another hot spot on the incentive contract road. Congress looks at these contracts without enthusiasm. Before they go into widespread use, an investigation by a House Armed Services subcommittee is probable.

Investigatory activity into defense contracting in all areas is up the ante to Congress, especially through its General Accounting Office. Industry has smarted under charges of waste leveled by GAO but has remained silent ostensibly in deference to the customer. The merry-go-round that now is beginning to spin—with industry, Congress and defense and space officials at tangential poles—will force a change in industry response, individually and through the Aerospace Industries Assn.

Spares procurement—a $1.2 billion annual item for aeronautical material—is another area of conflict, one which is related to the proprietary rights controversy.

Always a bread and butter business, spares can be a substantial source of income long after a system has phased out of production. Faced with stiffer procurement policies or with more intense competition, contractors have come to see spares, in some cases, as a primary source of profit rather than the system or subsystem itself which

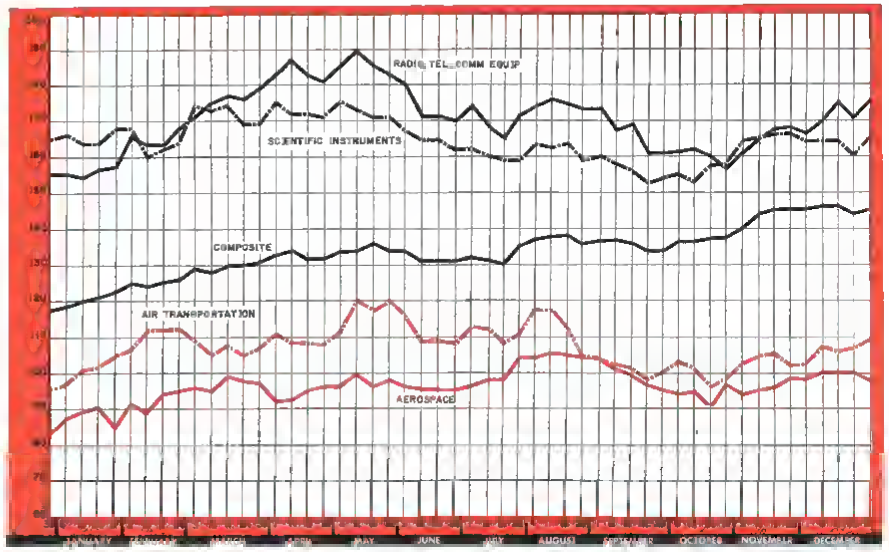


MONTHLY DEFENSE DEPARTMENT prime contract awards and procurement obligations are charted according to Census figures. Note Berlin crisis bulge.

U.S. Aerospace Employment

YEAR	Aerospace vehicles and parts (total)	Aerospace vehicles	Aerospace engines and parts	Other aerospace parts and equipment
Total Employment (thousands)				
1954	762.9	470.0	176.2	n.a.
1955	761.3	466.6	166.0	n.a.
1956	837.2	494.4	194.9	n.a.
1957	895.8	319.0	213.2	n.a.
1956	783.6	448.5	184.3	150.8
1959	755.4	425.1	162.0	148.3
1966	672.6	271.9	170.5	131.9
1961*	667.0	360.9	161.6	124.3
Production Workers (thousands)				
1954	560.2	325.1	121.6	n.a.
1955	525.5	322.5	106.5	n.a.
1956	561.0	330.3	122.5	n.a.
1957	591.4	342.4	122.1	n.a.
1958	499.4	267.6	107.5	104.3
1959	462.6	260.8	103.7	96.2
1960	392.5	215.6	94.9	81.9
1961*	377.4	196.9	101.2	70.3
Average Hourly Earnings (includes overtime premiums)				
1954	$2.07	$2.08	$2.05	n.a.
1955	2.16	2.17	2.12	n.a.
1956	2.27	2.27	2.24	n.a.
1957	2.35	2.35	2.35	n.a.
1956	2.50	2.51	2.51	$2.44
1959	2.62	2.64	2.64	2.55
1960	2.70	2.71	2.73	2.65
1961	2.77	2.78	2.81	2.71

n.a. Not available
* estimated
Source: U.S. Bureau of Labor Statistics



TREND OF 1961 stock prices of the aerospace industry and airlines shows relation to other industries and industry as a whole. Based on Securities and Exchange Commission data, the index takes 1957-59 price averages as 100.

may have been won on a breakeven basis at best.

GAO has attacked what it termed excessive cost of spares, and perhaps as a gesture to small business, criticized the lack of competitive bidding. Not all small business considers competitive bidding a panacea in defense contracting, however.

The Strategic Industries Assn., which numbers many smaller defense contractors in its membership, has been waging a strong campaign against requirements that defense contractors furnish complete drawings of proprietary items bought through prime or subcontracts. What the association is fighting is not the paper work involved, but the policy the government may then follow of using the drawings to prepare specifications for a competition for manufacturing follow-on orders of the subsystem or spares.

Major system contractors face this same problem. In the TFX decision, the Defense Department was partly motivated in awarding two study contracts to General Dynamics and Boeing by the desire to obtain proprietary information gained in thousands of man-hours of company-sponsored studies for only $80,000 or $90,000.

In any event, competitive bidding is due to be a larger factor in spares procurement. One of the first studies made by the Logistics Management Institute, a nonprofit corporation organized by DOD to analyze Pentagon buying procedures, dealt with spares. On the basis of its recommendations, DOD plans to double amount of competitive bidding for aeronautical spares from 15 to 30% of the total.

Creation of the Logistics Management Institute was one of several innovations and reorganizations last year that will affect the way the aerospace industry does business in the future. These include creation of:

- **Air Force Systems Command** which will handle development and procurement of all USAF weapon systems, and the Air Force Logistics Command, which will handle logistic support of weapon systems after they become operational. This recognized the changing complexion of aerospace procurement from a mass production to an R&D orientation.
- **Defense Supply Agency**, which now buys various military housekeeping items, including petroleum, but which may assume, as a Defense Department function, the procurement of electronic equipment and aeronautical spares.

Other changes more or less directly affecting industry economics include authorization for the Army to procure its off-the-shelf aircraft directly, combining of Tactical Air Command into a U.S. Strike Command, and budgeting by function rather than service. The Army will centralize all R&D, spread among the Ordnance, Signal and Transportation Corps, in a Research & Materiel Command.

Other areas of intensifying scrutiny:

- **Accuracy of cost and time estimates.**
- **Entertainment costs.**
- **Research and development costs.**

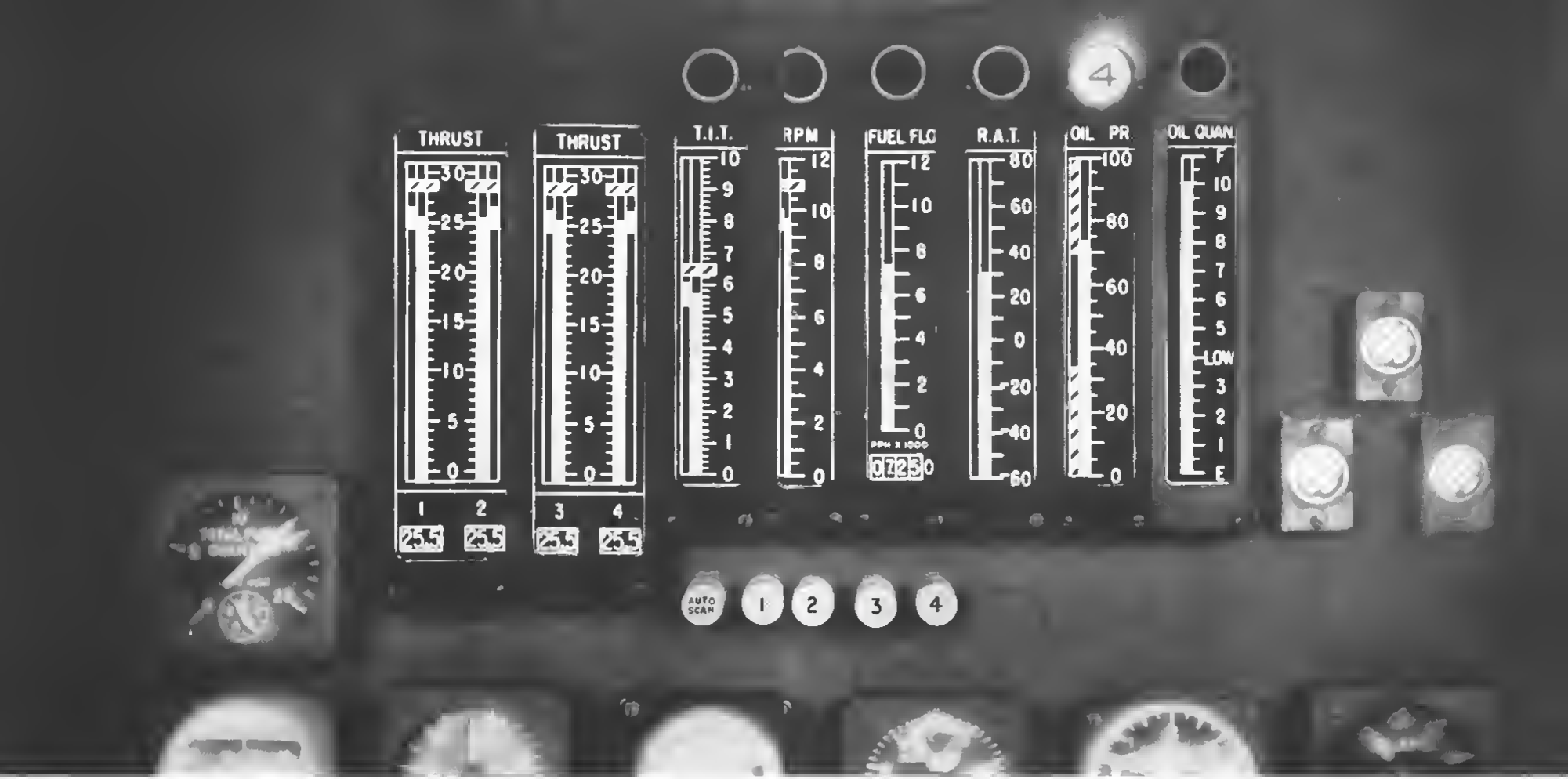
Company sponsored R&D, picked up as a part of overhead on some prime contracts or directly sponsored in other cases had turned into more and more of a company financed operation by early last year. Now Defense Department has instructed the services to overhaul their R&D contracting, use more fixed-price contracts and tighten management and control (AW Feb. 5, p. 26).

Burgeoning costs, which meant absorption of half the Fiscal 1962 R&D budget to pay for overruns on previous years programs, prompted the order.

Deeper delving by government into industry management of programs, as specified by the R&D directive, will be true across the board. This will range from NASA emphasis on commitment of specific management personnel on such projects as Apollo to stricter monitoring of routine purchasing practices.

Though not in name, the industry will find itself—as fruition of the trend over the last several years—working increasingly under what amounts to a price control system.

The Aerospace Industries Assn. basic



TROUBLE IN ENGINE #4

Spot it fast with the new Bendix propulsion data system. This advanced digital computer system offers a new high-visibility vertical scale display that simplifies engine management and saves panel space. The system *automatically* monitors parameters of *all* engines 2½ times each second . . . continuously displays the worst performance of each parameter . . signals when to take corrective action. Vertical scale instrumentation features electro luminescent lighting and provides a running visual comparison of actual performance with optimum and "never exceed" values. Each engine can be monitored separately when desired.

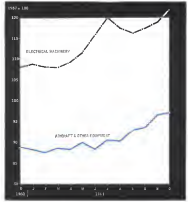
The system handles engine management for an entire flight profile. It relieves crews of time consuming manipulations required by engine management charts. The results are a considerable increase in efficiency of engine performance, increased fuel economy, and longer engine life.

This new Bendix propulsion data system is adaptable to any number of engine functions and to any type airplane . . . turboprop, turbojet, VTOL, STOL, multi-engine and single-engine. On a typical four engine turboprop aircraft requiring 36 indicators to present 36 conditions of engine performance, the new system presents 80 conditions of engine performance on 10 indicators in ⅓ less space. Developed by Bendix in cooperation with the Air Force's Flight Vehicle Section, Aeronautical Systems Division, the system offers a new concept in aircraft engine management efficiency. Write to us in Teterboro, New Jersey, for a copy of our booklet, "Propulsion Data System."

Eclipse-Pioneer Division
Circle Number 209 on Reader Service Card

The Bendix Corporation

WHERE IDEAS UNLOCK THE FUTURE



PRODUCTION INDEX compiled by the Federal Reserve Board shows the aircraft industry returning to 1957 levels Index is based on man hours.

list of 12 major airframe manufacturers has less and less represented the actual complexion of the industry AIA itself abandoned financial reporting based on this list last year

Now new procurement trends in the Pentagon will have further impact on the industry's makeup

Program packaging, the Pentagon's exercise ordered by DOD Comptroller Charles J Hitch in costing-out programs over five years or more and developing requirements through a series of trade-offs of price versus performance is concentrating procurement into fewer and presumably firmer funded programs Reduced as a result will be alternate approaches or investigation of programs with potential but unproved feasibility and the opportunities they offered to companies to develop them into requirements And technological feasibility is no longer accepted as reason for a development program

DOD is determining individual service procurement of major weapon systems Not only will this mean curbing one service or another in seeking what sometimes become rival weapons to perform the same mission but DOD is attempting to reverse the pattern by standardizing on one system for two or three services The effect on individual companies is plain

These are the major programs that will command the largest commitments of Defense or NASA funds

- **Apollo lunar capsule** Estimated total cost approximately $20 billion Initial funding for North American Aviation Space and Information Systems Division which will build the capsule is expected to be about $400 million General Electric also will play a major role in this vehicle
- **Saturn space booster** Chrysler Corp., winner of the S-1 booster received $200 million initial funding, and estimates of total value run as high as $600-$700 million Boeing, which won the S-1B booster that is expected to be the larger of the two programs, was expected to be funded initially at more than $300 million.
- **TFX bi-service fighter** Boeing or General Dynamics Ft Worth have study contracts, one to be chosen for final award Total program costs are estimated at $4 5 billion
- **Minuteman solid propellant ICBM** Funding proposed for Fiscal 1963 is $2 1 billion Boeing is assembly and test contractor but Thiokol Chemical Corp., Aerojet General Corp and Her

culcs Powder as contractors for the three stage motors, North American Autonetics for guidance and Avco Corp for re-entry vehicle share heavily in the program

F4H Phantom II and USAF F-110 This airplane which DOD ordered bought in both Navy and USAF versions is proposed for $1 1 billion in Fiscal 1963 McDonnell Aircraft Corp., the manufacturer, also is building the Gemini two-man space capsule

• **USAF C-141** turbofan cargo transport Lockheed Marietta has this contract funded at $208 million in Fiscal 1963 proposed budgets

• **Polaris fleet ballistic missile** Lockheed Missiles and Space Division is contractor for this program for which $2 billion in Fiscal 1963 funding is proposed Lockheed also has the Midas and Samos early warning and reconnaissance satellites which may become major programs

■ **Skybolt** air-launched ballistic missile Douglas Aircraft Co is contractor Fiscal 1963 funding proposed is approximately $500 million

• **Titan 2 and Titan 3** Details of these programs are not clear, but some early discussion of Titan 3 included total program funding of $600 700 million

Other major programs, most yet to be awarded, include the mobile medium range ballistic missile (MMRBM), the VAX attack aircraft, the NASA Nova space booster and its related large solid propellant motors, and the Nike Zeus anti-missile missile in which Douglas Aircraft plays a major role Uncertainty dampens the potential each of these programs has as a source of business

Program Impact

An indication of the impact of the major programs is a prediction by North American Aviation's president, J L Atwood, that the company's sales could be as high as $1 5 billion in 1962 This would be the largest in the company's history

Implications of this list—if it can be taken as a literal guide, if the Administration does stick to this program package composition and if Congress accepts it—are of an industry comprised of a smaller number of major systems contractors

Perhaps the major question raised for the companies which missed the major programs is the future of what might be called intermediate business An example is the fate of Air Force and Navy utility aircraft purchases. Lockheed Grumman and Fairchild all lost orders, relatively small in terms of the big program packages but still important business for the companies, when these aircraft were cut out of the Fiscal 1963 budget

Concentration on fewer bigger, longer term programs could mean the end of a traditional way of doing business for aerospace prime contractors No longer will a company be able to shrink to a design team cadre whose goal is to win the next contract next month or next year if the next time doesn t come for two years, in three, or five

They will face the problem of retention of design teams, since their technical people will tend to follow migration of contracts either for economic reasons or in an effort to remain with their field of interest

Their capital resources will be severely taxed As in the case of one major company in particular last year, ability to borrow short-term bank money will decline at the time it may be needed most because of the parallel decline of government receivables which the banks require as security

Some have invested substantial sums of their own funds in facilities, especially for research and development Support of such laboratories without production business may be a burden

Their choice thus may be to join the growing subsystem support tier, merge or vanish Thus the U S industry is facing, in subtler form, the 'rationalization' undergone by the British aviation industry

All these assumptions fail to include the political factor But the political factor is not an easily predicted one

Local interests will react with pain to any cutbacks affecting employment and prosperity in their communities—witness the New York response to threatened declines in employment at Republic Aviation Corp , whose F 105 fighter bomber program is being supplanted in funding by the F4H Proposing that award of the F4H contracts be done only on the stipulation that substantial subcontracts go to Republic, New York officials carried their plea right to the White House

Yet, amid all the speculation of contract awards on a need basis, economic and political considerations have shown little sign of dominance when programs crucial to national defense or prestige reached the decision stage With the chips down, dependability becomes a keystone

In cases of proposals with roughly equal technical merit, the story may be different

Certain elements of allocation of space funding are avowedly economic Broad distribution of space contracts is sought as a means of gaining the widest support for the space program For this reason, automobile industry participation in the program was sought

Sen Robert S Kerr (D Okla), chairman of the Senate Aeronautics and

● SPECIFICATIONS

Space Sciences Committee, was explicit in appealing to the economic interests of fellow Oklahomans in a speech last year (AW Nov. 13, p. 31). Money to send a man to the moon will be spent here on earth, he said, and many Oklahomans would participate in the economic growth the space program portended.

Thus while NASA selected North American Aviation as Apollo contractor largely because of NASA's confidence in the same team that successfully carried out the X-15 project, much of the production work will be done in part of the Douglas Aircraft plant at Tulsa, Okla., which North American will take over.

New Idea for Comsat

Another Administration proposal in the space field may also have a profound influence on the future of the aerospace industry. This is the plan to establish, under government aegis, a privately financed and managed corporation to develop and operate commercial communications satellites.

The corporation would be authorized to issue 1,000,000 shares of Class A voting stock entitled to dividends at a minimum price of $1,000 a share and 10,000 shares of non-voting, non-dividend paying Class B stock available only to the communications common carriers. Each issue is designed to obtain $1 billion each in capital for the corporation.

Financial sources foresee such a corporation as laying a foundation for radical departures in handling other programs.

If the communications satellite corporation meets the government's objectives, they ask, why not finance a supersonic transport the same way?

Aerospace manufacturers appear to be through the worst of their write-off and write-down troubles, most due to costs of commercial jet transports that exceeded estimates and sales that did not. Last year it was the turn of the avionics and components suppliers, faced with high-priced inventories whose values fell in the face of competitive price cutting or shifts in technology.

This year it may be the airlines' turn. Trans World Airlines at the end of 1961 wrote down its piston aircraft fleet, either retired or to be retired, to a 3% residual value to reflect a realistic resale value.

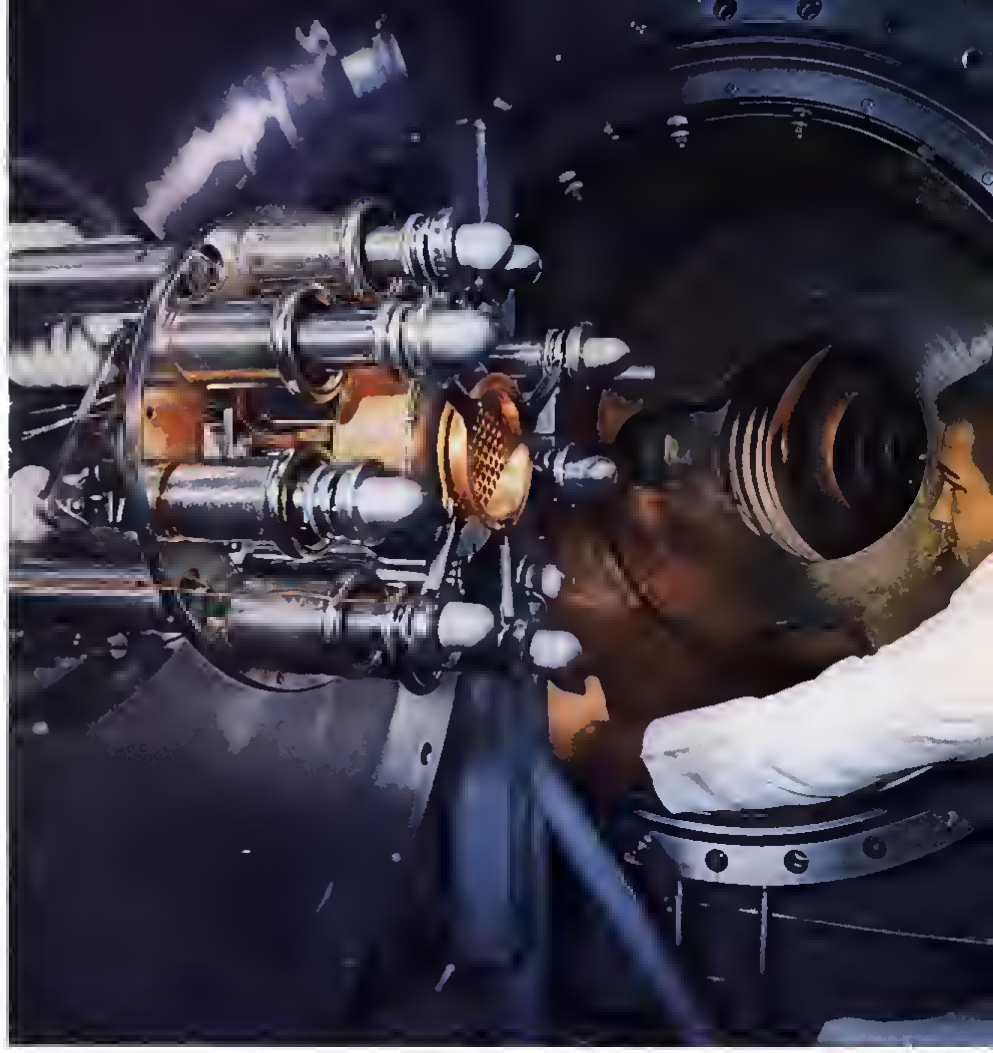
TWA because of its long delay in arranging its jet financing, was late in phasing out piston aircraft. But another factor to consider, which could affect other airlines as well, is a new effort by the Civil Aeronautics Board to gain control, through legislation, of depreciation rates.

POWERED BY FOUR ***ROLLS-ROYCE*** *CONWAY TURBOFAN ENGINES*

BRITISH AIRCRAFT CORPORATION

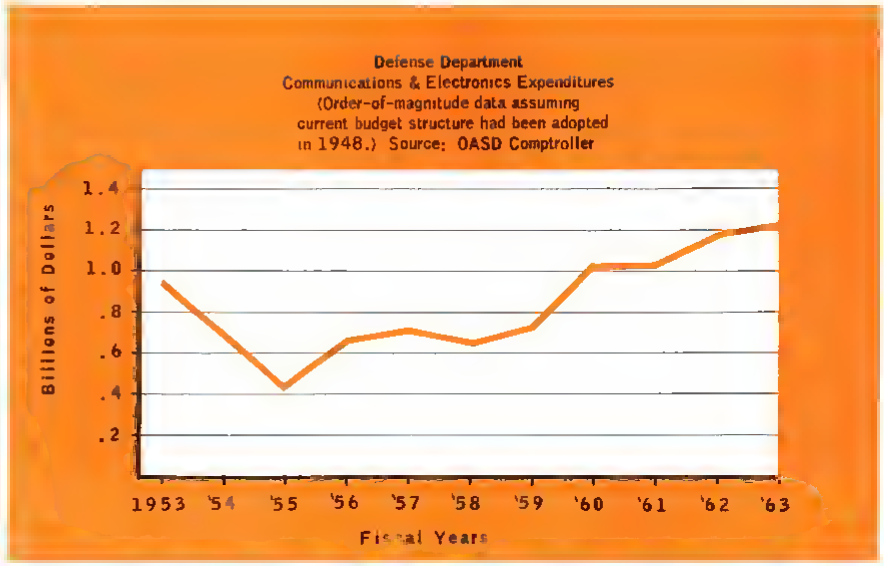
ONE HUNDRED PALL MALL LONDON SW1 ENGLAND
USA BRITISH AIRCRAFT CORPORATION (USA) INC.,
399 JEFFERSON DAVIS HIGHWAY ARLINGTON VIRGINIA

YEA BVC 24



ELECTRO-OPTICAL SYSTEMS 61 beam cesium ion engine mounted on flange is prepared for vacuum chamber test at Pasadena, Calif

Avionics



Competition, Reliability Challenges Loom

By Philip J. Klass

Many avionics companies will face a moment of truth in one or more areas of their operations during the next 18 months.

Prospective increases in budgets for defense and the National Aeronautics and Space Administration in Fiscal 1963 normally should produce a bullish atmosphere.

But with few exceptions, the question, "How's business?" brings the response: "Never saw such tough competition or so much of it."

The fission process of the last decade that produced hundreds of new avionics companies has tapered off and has been followed by a not surprising rise in mergers. But the efforts of small firms to stay alive, coupled with the learning-like drive of most companies to diversify, has resulted in today's intensely competitive situation.

Bidders' Wonderland

At a recent bidders briefing conference for procurement of a large system, which one Pentagon official says required a capability held by no more than a dozen companies in the nation, 92 requested invitations to attend.

Despite this intense competition the general mood of the avionics industry is not one of discouragement. Changing technology, which has hurt certain segments of the aerospace industry, has opened attractive opportunities for avionics manufacturers. For example:

• **Optical maser (laser),** which existed only in theory three years ago and was a laboratory curiosity a mere 18 months ago, has opened a market for a variety of new devices and systems for military, space and civil uses. These range from the whole new field of radiation weapons (AW Oct. 23, p. 19), to the use of lasers for missile guidance, satellite tracking, space and terrestrial communications, welding and medical uses (AW Jan. 15, p. 92). Because of their comparative simplicity today, a host of companies are now engaged in laser research and development. Hardly a week goes without a new advance reported in laser technology.

• **Electric propulsion,** for space vehicle use, opens an entirely new market for avionics manufacturers, and one which draws on existing know-how. Rocket and jet engine manufacturers are also in the field. In fact, there are more companies engaged in research and development on various types of electric engines than the combined total of jet and rocket engine producers.

Since the market for electric propulsion presently appears to be more limited than either the rocket or jet engine fields, heavy attrition in this area can be expected.

• **Microelectronics,** in its various forms, until recently considered an exotic area of research and development which only a few companies could afford to support, today has become a technology in which nearly all avionics manufacturers grossing more than $40 million a year feel obligated to develop an in-house capability.

This activity has or threatens to put the avionics equipment manufacturer into direct competition with companies that formerly were its component suppliers, particularly in the fields of resistors, capacitors and printed circuit boards.

It is not surprising therefore that increasing numbers of the larger component manufacturers are attempting to move into the microelectronics field. Because smaller component makers may not have the capital and/or circuit design skills needed to support such a competitive program, many observ-

USAF Support Systems

Fiscal 1962 and Requested Fiscal 1963
New Obligational Authority
(In millions)

System Number	Function	Fiscal 1962	Fiscal 1962
412-L	Air Weapons Control System	$19 6	$30 1
416-L	Continental Air Control & Warning	$111 5	$78 6
425-L	Naval Combat Operations Center	$6 9	$9 9
431-L	Traffic Control & Landing System	$14 8	$20 1
433-L	Weather Observing & Forecasting	$5 6	$8 1
438-L	Intelligence Data Handling System	$5 4	$7 5
465-L	SAC Command & Control System	$63 6	$43 1
466-L	Electromagnetic Intelligence System	$58 2	$37 8
473-L	USAF Hdqtrs Comm & Control	$7 6	$18 0
474-L	BMEWS (Ballistic Missile Warning)	$68 3	$34 0
477-L	Nuclear Detection System (Nudets)		$3 0
480-L	Air Communications System	$75 1	$59 5
Misc	Cryptography & Other Systems	$34 0	$49 0
	National Comm & Control System		$14 6
	Post-attack Communications System	$2 0	$5 0
	Missile Communications Support	$137 7	$37 8
	Modernization of Comm & Elec	$38 0	$27 5
	Supply & Maintenance	$127 9	$145 0
	Organization & Base Support	$1 6	$3 2
	Industrial Facilities	$4 0	$4 3
	TOTAL	$782 0	$636 1

ers expect to see future triggers in the component field.

● **Radar technology**, which only a few years ago appeared to be approaching the end of the line in terms of performance, has been greatly spurred by the requirements for ICBM defense and space surveillance, and by advances in low noise amplifiers—masers or parametric amplifiers—by electronically scanned antennas, and by strides in the power available from transmitting tubes.

Some avionics manufacturers will soon face critical challenges in space technology. Sophisticated vehicles with complex avionic payloads will be launched in increasing numbers during the coming 18 months. This includes prototype commercial communication satellites the first of the Army's Advent communication satellites, the Nimbus meteorological satellite and the Air Force satellite Inspector designed to rendezvous in orbit.

As boosters become more reliable, placing an increasing percentage of space vehicles in intended orbit in trajectory attention will then center on how well, and how long, the avionic payloads function in space.

As the novelty of space operations wears thin, there will be increased criticism when payloads malfunction or stop operating after only a few days in orbit—particularly when Congress totals the expense of unsuccessful missions in NASA budget time. An indication of what lies ahead can be found in the current disappointment over the failure of Ranger 3 to hit the moon or even to return usable lunar surface photographs as it passed by.

Avionics manufacturers generally can expect that research, development and pilot production quantities with their relatively low profit margins will become an increasing proportion of total company business as large-scale produc-

tion dwindles. This will have several important effects on company operations.

▪ Demand for engineers and scientists will increase, perhaps sharply, resulting in instability in technical staffs. Unless companies are able to hold onto key personnel, the penalty for loss and subsequent hiring of and integrating new technical personnel into the organization will be schedule slippage and cost overruns. This comes at a time when the Defense Department is taking steps to crack down on schedule slippage and overruns and is talking about the possibility of penalizing delinquent contractors to the point of excluding them from bidding on future programs. (AW Feb. 5, p. 26)

▪ New facilities will be needed, especially for companies in space technology, —air-conditioned, super-clean factory assembly areas and facilities for simulating space vacuum, solar radiation, and vibration and shock. At the same time, companies may find themselves with a surplus of conventional factory floor space which, unless put to use or disposed of, will increase company overhead and hurt its competitive position.

Good Technical Management

Defense Secretary Robert S. McNamara and the Office of the Director of Defense Research & Engineering are becoming increasingly critical of the management of research and development programs both by the services and by industry. Famous as it is for its efficiency in the factory and on the production line, U.S. industry has not yet devised techniques for effective management of large technical groups engaged in research and development, in DOD's opinion.

In former years, when the R&D tasks were not so formidable, cost overruns could be liquidated against subsequent large-scale production. Today, where production quantities seldom total more than a few dozen units and often fewer and where R&D overruns often are much larger, costs cannot be recovered so easily.

Many of today's weapon and support systems require hundreds or thousands of engineers during the development period. This poses severe liaison and coordination problems among members of the team and between the team and top management. If management attempts to exercise too tight control, engineers find themselves spending much of their time writing progress reports with too little time left to make progress. If control is loose, the program often moves slowly and the effort is diffused along undesirable tangents.

Even if industry management was able to devise efficient methods for directing and controlling the efforts of large technical teams, its efforts often

would be largely defeated by present procurement policies of the government.

James M. Bridges, director of the Office of Electronics in the office of the Director of Defense Research and Engineering says: "Time after time I have seen teams of engineers, trained in specialized areas, that were literally out of a job while a new team was being assembled and trained in another company to handle a similar research and development task."

The result is that engineers often will leave and follow a new defense contract to stay in their chosen field of specialization rather than remain and work on programs in which they are not interested or qualified. But upon arriving at the new company, the engineers must adjust to their new associates, new management procedures and corporate practices, all of which results in a net loss to the defense effort.

Defense Department officials recently have taken steps aimed at improving this situation. If top-level policy directives are converted into effective action at the working level, they hold important implications for the entire aerospace industry.

John H. Rubel, deputy director of the Office of Defense Research and Engineering, said in a recent memorandum to each of the three service assistant secretaries for research and development that new procedures are needed for soliciting and evaluating bids.

"The criteria set up for bid evaluation must be carefully scrutinized and should be made to include an assessment of present and past contractual performance as a major selection factor," Rubel said.

"Companies with little or no prior experience are often given contracts a few months before experienced companies find themselves running out of similar work with a trained staff beginning to leave because of the situation."

Rubel called on the services to exercise better judgement in the time phasing of their requests for proposals. More careful analysis of manpower requirements for new projects is needed, he said, to determine the availability of key manpower resources within companies competing for new business.

Rubel said that turnover of engineering personnel in some areas is ridiculously high partially as a result of existing procurement selection practices. Industrial management, he warned, should know that its chances for future contracts will suffer if it is not able to maintain a stable, high-quality technical team.

Both industry and government com-

plain of the effort and cost that go into the preparation of proposals for bidding on new procurements. On one major program, the cost of preparing proposals submitted by all bidders totaled one half the total engineering cost of performing the work to be awarded, according to Bridges.

But cost figures do not reveal the extent of the drain on the nation's technical manpower because a company usually assigns its best, most creative engineers to proposal preparation, diverting them from more productive labors.

With some justification, industry blames the Defense Department for not establishing uniform rules which would limit the length and artistry which companies must put into their proposals to stay with their competitors.

Defense officials, on the other hand, criticize industry for its lack of self restraint and selectivity. In the drive for diversification companies often seek the opportunity to submit a proposal in a field in which they have little experience or competence.

Selectivity Attempt

Radio Corp. of America's Defense Electronics Products group is one of several attempting to exercise greater selectivity, not just to hold down proposal costs but to concentrate its energies on more important programs, according to Arthur L. Malarney, executive vice president. Each division in this group singles out three major projects which it believes offer the most significant potential for its future growth.

Under the direction of the group's central marketing department, the company then seeks to bring to bear all of its corporate know-how and resources to win these programs. Within each of the several divisions there is an effort to use greater selectivity in picking smaller jobs to bid, according to Malarney.

If the Defense Department takes concrete steps to base its contractor selection more heavily on past performance and demonstrated corporate capability, much of the commercial puffing that now goes into proposals can be eliminated.

In its place contractors will be asked to propose technical trade-offs which will cut development cost and or time without seriously affecting over-all weapon or system performance.

Competence which a contractor demonstrates in his proposal in suggesting technical trade offs which have little effect on the military usefulness of the weapon or system but a sizable effect on its development time and or cost, is expected to count heavily in selecting a winning bidder, if current Defense Department objectives are carried out on the working level.

Government Funded Optical Maser R&D Programs

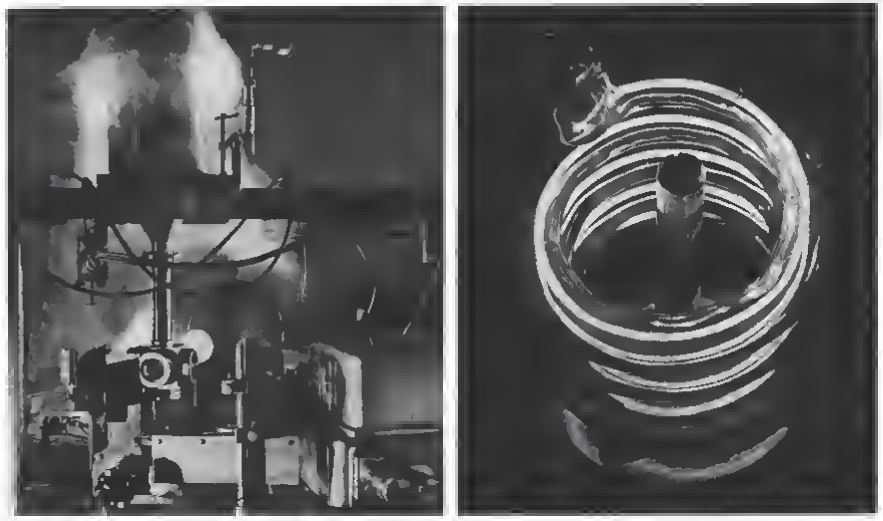
Organization	Program	Supporting Agency	Dollar Value (in thousands)
Alpenc P. Aigrain (Paris)	Semiconductor masers	ONR	$20,000
American Optical	Sun-powered laser transmitter	USAF/ASD	98,000
Atomic Energy Commission (Oak Ridge)	High-power gas lasers	ARPA	240 000
Bell Telephone Laboratories	Optical maser research	USASRDL	99_000
Columbia Radiation Laboratory		DOD	75,000
Corning Glass	Optical delay line	USAF	70,000
Electro-Optical Systems	Advanced optical maser components	USAF/RADC	100,000*
Electro-Optical Systems	Infrared laser (Semiconductor)	USAF/ASD	100,000
Electro-Optical Systems	Coherent optical surveillance components	USAF/RADC	90,000
Electro-Optical Systems	Materials for laser applications	USAF/ASD	100,000
Electro-Optical Systems	Laser beacon for daylight tracking & navigation	NASA	25,000
Harvard University (Applied Phys Lab)	Modulation techniques	DOD	70,000
Hughes Aircraft (Culver City)	Range finder Feasibility study	Frankfort Arsenal	38,000
Hughes Aircraft (Culver City)	Double pumping feasibility	ARPA/ USASRDL	300,000
Hughes Aircraft (Culver City)	High PRF laser transmitter for surveillance	USAF/ASD	65,000
Hughes Aircraft (Malibu)	Surveillance radar study	USAF	62,000
Hughes Aircraft (Malibu)	Coherent generation of optical radiation	USAF/ASD	370,000**
ITT Federal Laboratories	Infrared laser & harmonic generation	ONR	45,000
Icomal	Large cryotic	USAF	84_000
Litton Industries (Tube Division)		USAF	100,000
MIT Lincoln Laboratory		DOD	30,000
MIT Radiation Laboratory		DOD	100,000
Motorola	High intensity pump sources	USAF	52,000
Naval Electronics Laboratory	Gas laser	Navy	20,000
Naval Ordnance Laboratory	Lasers	Navy	60,000
Naval Ordnance Laboratory (Corona)	Fuzing	Navy	20,000
Naval Ordnance Test Station (China Lake)	Space track lasers	Navy	20,000
Naval Research Laboratory	Glass lasers	Navy	120,000
Nuclear Radiation	Pumping techniques	USAF/RADC	100,000
Optics Technology, Inc.	Film optics scanning techniques	USAF/ASD	87,000
Philco Research	Space Laser Communications	USAF	100,000
Quantatron	Infrared maser ranging system	GnWeps	88,000
Radio Corp of America	Narrow band sources, modulators & detectors	USAF	400,000
Radio Corp of America	Laser materials research	USAF/ASD	225,000
Radio Corp of America	Correlation techniques	USAF/RADC	95,000
Raytheon	Gas lasers		
Space Technology Laboratories	Liquid optical masers	USAF/SSD	150,000
Sperry Gyroscope	Modulator (500 to 1 000 mc.)	USAF	100,000
Stanford Electronics		DOD	50,000
Stanford	Maser research	USASRDL	40,000
Technical Research Group	Theoretical study of laser oscillations	USAF	25,000
Technical Research Group	Broad research in laser techniques & materials	ARPA/ AFOSR	250,000†
Technical Research Group	Broadband laser communications techniques	USAF/RADC	99,000
Technical Research Group	Modulation methods	USAF/ASD	50,000
Technical Research Group	Range finder feasibility	Frankfort Arsenal	35,000
University of California	Pulse inversion of electric dipole moments & modulated coherent optical emission	Army Ordnance	47,000
University of Dayton	Reflection back ground S/N detection study	USAF	50,000
University of Maryland	Microwave masers, optical pumping & infrared masers	ONR	18,000
University of Michigan (Project Michigan)	Materials, range finders and CW laser	USAF	70,000
University of Rochester	Investigation of optical masers	Army Ordnance	60,000
Watkins Johnson	Laser materials	USAF/ASD	100,000
Watkins Johnson	Optical maser (semiconductor)	USASRDL	150,000
Western Electric	Research in CW laser circuits & components	USASRDL	175,000††

* Follow-on to an initial $95 000 award

** Bids for four-part continuation contract under evaluation

† Second follow-on brings total program begun in 1959 to $1.75 million

†† Bids for continuation program under evaluation



INFRARED MASER experiment conducted at Electro-Optical Systems, Inc., seeks to determine line widths of emission from semiconductors (left). Ruby pulsed optical maser (right) developed at Hughes Aircraft Co. consists of a single crystal rods rod surrounded by helical lamp which pumps energy into rod. Scores of avionics companies, many under government contracts, are conducting research in optical masers in anticipation of a multitude of possible aerospace applications.

Government Funds Boost Laser Research

By Barry Miller

Optical masers are emerging as the prime target of an unexpectedly large number of government-funded research and development programs, principally because of the enormous potential these new sources of electromagnetic radiation offer for aerospace applications.

More than 75 active government-supported research and development programs in optical masers (lasers), associated techniques, systems and circuit considerations, are being supported, primarily by the Air Force, Army and Advanced Research Projects Agency. Many more are on the horizon. One eastern avionics company alone was invited to bid on nine separate optical maser programs in a single one-week period last month.

If research now under way or contemplated this year progresses as scientists anticipate and the military hopes, this fledgling technology may blossom as the microwave field did beginning in World War II. The pace at which the field is advancing and the acceleration of military financing of it, surprises even its more optimistic adherents.

Rising Volume

Estimates of the dollar volume of current optical maser R&D efforts must be revised upwards periodically in the light of an outpouring of new programs from almost every military procurement agency. An accompanying list of over 50 current programs, most at or below the $100 000 level, totals over $5 million; other programs in negotiation now or for which bids have been requested will match or surpass this figure. To this must be added a sizable volume charged to other military programs and vast efforts supported by the aerospace industry.

The reasons for this mounting interest and investment are several. The optical maser provides for the first time a source of coherent controllable electromagnetic radiation in the optical region—a portion of the spectrum roughly four or five decades above the high end of the microwave frequency region. This opens a new electromagnetic area for active avionic systems.

Outputs of the optical maser are narrow band in spectral width—coherent—and have an inherently large information capacity because of the high frequency. The beams are theoretically almost parallel. The amounts of output are potentially large, making possible optical communications over huge distances. The collimation of the outputs permits focusing of the beam to give extremely high power densities, sufficiently large with early devices to vaporize metals in laboratory experiments.

"Fundamentally, there is no limit to the power which can be obtained from the optical maser," Dr. Charles H. Townes, co-author of the optical maser concept, said last summer at the Air Force/Aerospace Corp. Symposium on Ballistic Missile and Aerospace Technology. The limit he pointed out, is a matter of engineering and heat dissipation. Yet this limitation is slowly being overcome and peak output powers are sharply rising.

A Hughes pulsed optical maser generated a peak power of roughly 10 kw in the summer of 1960. Townes, a year later, cited 20 or more kilowatts peak power available from ruby devices. Scientists at the Hughes Malibu Laboratories have demonstrated the possibility of generating tens of megawatts a company engineer reported at a recent

technical meeting. Indian peak power outputs from pulsed devices have climbed to 14 megawatts. This power level from what may still be regarded as relatively primitive devices is extremely attractive for radar, perhaps for pulse position modulation communications systems.

Sensing Significance

The Air Force can take credit for sensing early the significance of optical maser developments and for vigorously encouraging and pressing necessary R&D. USAF technical people recognized the feasibility of active optical systems in space where they would be free of the attenuating and scattering effects of the earth's atmosphere. Semi-active guidance communications, navigation, surveillance and reconnaissance systems are all possible applications.

For surveillance radar and beam riding guidance systems the optical maser may offer unusually high angular resolution. For communications, it is attractive because of highly favorable combinations of bandwidth range and power requirements. The extremely narrow beams provide an inherent communications security, almost invulnerable to jamming. The high energy densities suggest several applications ranging from machining or welding to radiation weapons.

The principal Air Force and Army agencies directing optical maser R&D include Aeronautical Systems Division, with active participation of several of its laboratories, Rome Air Development Center and the Signal Corps.

All three services are investigating through a number of industry programs the possibilities of optical maser radiation weapons. These might use the high-energy density concentrated in the maser's narrow beam to vaporize metals at appreciable ranges. If practical feasible and practical, these might prove to be tactical in space weapons or a technique of knocking out ballistic missiles.

Radiation Studies

To explore these possibilities, the Air Force, through ASD and RADC initiated at least five studies and terminated other (AW Feb. 12, p. 23; Oct. 23, p. 19). The Army began a large multi-company investigation and its Frankfort Arsenal has asked for development of a small hand radiation device. Navy's Bureau of Ships reportedly will start its own study shortly.

An indication of the breadth of service funded programs in optical masers and related topics as well as ultimate applications suggested by them may be inferred from the following examples of programs now on bid or under evaluation:

• Infrared maser research—Two programs in infrared maser research, one

theoretical, the other applied, will start when the Army Engineers, Ft. Belvoir, Va., complete an evaluation of proposals recently solicited from industry.

● **Satellite tracking**—Contract to develop an optical maser transmitter to be used with a 48-in. telescope and auxiliary equipment to track earth-orbital satellites from a mountain peak in southern New Mexico will be awarded soon by Aeronautical Systems Division (AW Jan. 15, p. 95).

● **Modulators, demodulation techniques**—Army and Air Force are intensifying investigations of suitable modulation and detection schemes without which communications or radar potentialities of optical masers cannot be exploited fully. Aeronautical Systems will soon launch a program seeking an optical modulator with high information capability, suitable for use both with coherent and quasicoherent light sources and capable of transmitting at least 25% of light emitted by a source. Signal Corps is awarding a contract for a solid state detector demodulator for optical maser communications systems.

● **Machining, welding**—Sources to develop optical maser equipment and techniques for such application were solicited late last year by Aeronautical Systems. Scientists working on these devices frequently refer to the "Gillette" power of a maser—the number of stacked razor blades through which a laboratory optical maser can burn holes.

● **Radiation weapon investigation**—A phased-array optical maser radiation weapon in which the outputs of multiple optical masers would be combined to increase available output power will be studied under a $500,000 contract. Aeronautical Systems Division plans to award soon.

● **High-intensity pumps**—A contractor will be selected soon by Aeronautical Systems to conduct R&D in high-intensity pump sources, as the search for more efficient, better quality techniques of exciting optical masers continues.

● **Optical maser crystals**—A program to investigate techniques for producing aluminum oxide, calcium fluoride and other crystalline/noncrystalline materials suitable for optical maser applications will be started by the Army Signal Corps (AW Feb. 5, p. 23).

● **Millimeter wave masers**—Success with optical masers has stimulated a renewed interest in coherent sources for the millimeter wave region, which is sandwiched between the microwave and optical regions. Army Signal Supply Agency recently asked for proposals for a packaged millimeter wave maser amplifier. Aeronautical Systems is seeking development of masers supplying continuous wave outputs above 100 gc.

● **Basic studies**—Proposals for a $1 million four-part optical maser research and

Why so many?

We admit it.

Amphenol, more than any other connector manufacturer accepts responsibility for confronting you with a seemingly endless selection of rack and panel connectors.

There's a good reason.

For some uses, a ten-contact connector the size of an Idaho potato will do just fine. In others, ten connections must be squeezed into a space no bigger than a jelly bean. Still other applications have unique requirements that relate to environment or mating force—even the technical skill of the operator.

WHY WE DO IT

We make a lot of different rack and panel connectors because it takes a lot to satisfy the wide range of applications.

For example, the Amphenol Blue Ribbon® rack and panel connector is widely used in "blind" mating applications. Part of Blue Ribbons popularity is due to the fact that they mate with a smooth and gradual wedge-like force. Because they mate so smoothly, the "feeling" of correct alignment is unmistakable.

Another advantage of the Blue Ribbon design is the wiping action that occurs as connectors mate. Each time Blue Ribbons are mated, contact surfaces are wiped clean. Combine wiping action with high mated contact pressure, and the result is an extremely low-resistance connection.

THINKING SMALL?

As fine a connector as we know the Blue Ribbon is—it's just not right for the real tiny stuff. Thus, as miniaturized electronic equipment became popular, Amphenol engineers developed the Micro Ribbon®—a rack and panel connector utilizing the ribbon contact principle, but in as little as one-half the space. Further development produced a circular Blue Ribbon connector which crammed 50 contacts into a diameter just under 3 inches.

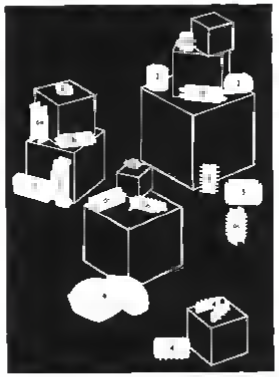
Also, there's the question of terminating rack and panel connectors. Often, confined quarters or complex wired harnesses can tax the dexterity of even the most skilled worker.

To solve this problem, Amphenol engineers developed rack and panel connectors with Poke-Home® contacts. Poke Home contacts make it possible to terminate conductors independent of the connector. Contacts are crimped, soldered or even welded to conductors, then inserted into the connector. Besides simplifying assembly, Poke-Home contacts can be easily removed *after* assembly should circuit changes or repairs later become necessary. Needless to say, Amphenol rack and panel connectors with Poke-Home contacts (Min-Rac 17®, 93 and 94 Series, for example) are popular items with engineers who are forced to think small, spacewise.

BEATING THE ELEMENTS

There's a need for environmentally resistant rack and panel connectors, too. High performance aircraft, missiles and space craft led to the development of Amphenol 126 and 217 Series environmentally sealed rack and panel connectors. (The 217 offers the added feature of Poke-Home contacts.) Other Amphenol rack and panel connectors can accommodate coaxial connectors; many can be supplied with hermetically sealed contacts. There are rack-to-cable connectors available in every series. There are super-economy types and super-reliable types.

So, when you have a rack and panel connector problem, contact an Amphenol Sales Engineer (or an authorized Amphenol Industrial Distributor). With the broadest line of rack and panels in the industry—if he can't solve it, no one can. If you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



Amphenol connectors shown on the opposite page are: **1**—Min-Rac 17 with (a) crimp-type contacts and (b) solder-type contacts. **2**—94 Series. **3**—Micro-Ribbon. **4**—126 Series Rectangular. **5**—93 Series. **6**—Blue Ribbon with (a) barrier polarization, (b) pin polarization and (c) keyed shell and barrier polarization. **7**—126 Series CNI. **8**—126 Series Hexagonal. **9**—Circular Blue Ribbon.

Status of Major FAA Facilities

	In Operation Jan. 1, 1962	Total Programed Thru FY '62	Additional Requested In FY '63 Budget
VHF Omniranges	*762	860	77
VOR-Teron Installations (VOR portion included in VHF Omniranges figures)	295	609	50
Enroute (long-range) Radar	49	81	3
Airport Surveillance Radar	65	84	0
Precision Approach Radar	27	28	0
Instrument Landing System (ILS)	216	266	0
Airport Surface Detection Radar	9	10	0
Radar Beacons	53	129	39
Approach Light Systems	153	210	25
Sequence Flashing Lights	144	210	25
Remote Air-Ground (Comm.) Outlets	291	322	28
Flight Service Stations**	409	411	—18**
International Fl. Serv. Stations	11	12	1
Air Route Traffic Control Centers	36	36	1
Airport Traffic Control Towers	256	279	15
Electronic Computers	6	6	0

*Formerly called Air Traffic Comm. Station. Includes those combined with airport towers.
**Convert Flight Service Station to Remote Communication Outlet

development program to explore materials, pump sources, crystal growth and device configurations are under evaluation at Aeronautical Systems. Contract may go to one or more companies since bidders were allowed to bid one or more of the four parts.

With the opening of optical wavelengths for active systems and refinements to optical masers bringing them to the verge of practicability, the need arises for compatible optical components and circuits with which to build complete systems. Various communications and radar techniques familiar to the radio engineer also require investigation for optical system applicability. Several examples:

• **Optical maser components**—An optical delay line is being developed under USAF contract by Corning Glass. An optical isolator, using Faraday rotation, for coupling a driver to an amplifier, was developed by Electro-Optical Systems under Rome Air Development Center contract. Electro-Optical is looking into phase shifters, power dividers and attenuators under a follow-on contract. Western Electric has been studying optical maser circuits and components under a sizable Signal Corps contract which will be continued either by Western Electric or an alternate contractor.

• **Equipment & systems techniques**—General Electric and Radio Corp. of America are investigating application of correlation techniques to optical maser systems. One idea is to locate possible distinctive signatures on optical maser pulses which would lend themselves to correlation processing techniques. GE is trying to find out whether the target of an optical maser radar may distinctively affect the returned echo so that additional information can be deduced from it. Both are looking at the effects of target material, texture and or angle of incidence.

Lenkurt Electric, affiliated with General Telephone, has looked into multiplexing techniques and presumably Bell Telephone Laboratories has, too. This could be the key to exploiting the large information capacity of optical masers. Bell Labs and ITT, among others, are exploring harmonic generation with optical masers. Hughes is conducting studies of variable pulse repetition frequencies. It has obtained two 0.1 microsecond pulses with interpulse spacing variable from 50 to 100 microseconds.

Much current research and development hinges on materials, their preparation and, in the case of most solids, crystal growth. Speaking before the National Winter Convention on Military Electronics Dr. Theodore Maiman, vice president of Quantatron indicated reasons for this. Known optical maser materials cover a narrow portion of the optical spectrum—from the red in the visible region, 0.69 microns of ruby, to infrared, 2.68 microns for a helium-neon gaseous system. Shorter wave

length devices, 2,500 to 5,500 angstroms, are desired to correspond with the peak sensitivity of phototubes which are likely to be the principal detectors in receivers. Shorter wavelength optical masers might bring maser visible light to the peak of the eye's response thereby bringing about a gain by a factor of 200. This might be useful for devices like auto-collimators for which optical masers are being adapted by companies like Chrysler (AW Jan. 29, p. 58).

Better, wider range continuous wave materials that require less intensity from a power source are also needed. CW devices at shorter wavelengths would lessen power requirements as a result of line sharpening at shorter wavelengths.

Crystals of higher quality, that are strain free with no inhomogeneities could appreciably improve maser operation. An optically perfect ruby, Maiman says, might enable a maser to produce 10 times the output power and cut beam angle by a factor of 10.

Materials Search

A search for new materials is not restricted to solids, or solids thus far operated in masers. Several companies are studying the possibility of optical masers using electron injection in semiconductors, a technique analogous to the successful use of electron excitation in a gaseous discharge. It could cut power requirements and raise device efficiency.

A few organizations, Maiman noted, his own company among them, are investigating liquid optical masers. At least one organization, Space Technology Laboratories, has a contract to study them.

The relative merits of the three media as cited by Maiman are:

• **Gases**—Superior for frequency stability and monochromaticity, gases have low efficiency, less than 0.1%, because of energy wasted in excitation of multiple energy levels during discharge.

• **Solids**—In principle, the solid system is more efficient than the gaseous, with the possibility that a perfect ruby might yield 3-10% efficiency. The solid displays a fair sized temperature dependence, however.

• **Liquids**—Arbitrarily large cells can be realized with liquids, thereby relieving the burden imposed on growing large crystals for solid devices. The liquid would be strain free and homogeneous at inception, although thermal gradients would develop in time and introduce apparent strains. Fluorescent line widths are broader than in solids which may make more difficult the operation of a liquid device. The liquid can be recirculated being in effect its own coolant, but turbulence may be introduced.

Eventually, Maiman suggests, all three types—not the first two alone—will be operating and satisfying comple-

RADAR SITE on Kwajalein atoll for Nike Zeus-Atlas warhead interception tests is shown in aerial photo. Installations (AW Feb. 26, p. 84) include support landing strip (left to right across top), acquisition radar receiver (white dome in center) and beam forming fence for transmitter (shown half completed at right center). Fence has now been extended to complete 360 deg. coverage.

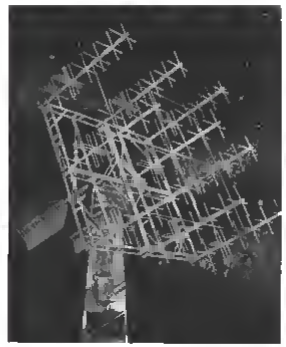
mentary needs, much as klystrons, magnetrons and traveling wave tubes do in the microwave range.

Pump sources are another master component demanding and receiving research and development attention. High intensity, rugged large exciting sources are needed so that it will not be necessary to push existing lamps beyond their limits.

Other companies active in the field are Westinghouse, General Electric, Varian, International Business Machines, General Precision, Martin-Marietta and Minneapolis Honeywell, all engaged in optical maser activity. Other organizations showing signs of interest are Lockheed, General Motors and Texas Instruments.

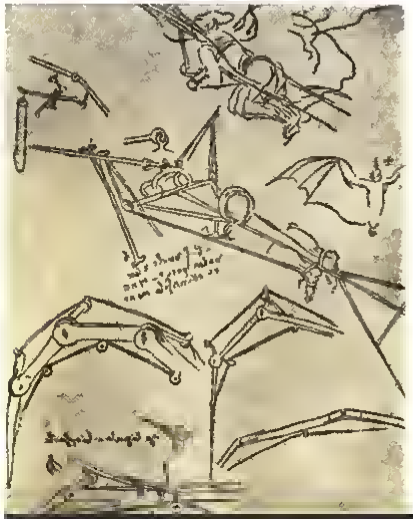
The next several years, depending on the direction of developments and the applications to be exploited by the military, may see an exchanging of position in this field and the entrance and exit of many companies as they better define their own roles in this new technology. Types of companies active today run the gamut of the avionics business, with a heavy sprinkling of radar, navigation and guidance specialists. These companies apparently sense the role their capabilities, experience and technology can play in achieving commanding positions in the field from which they could seek potential markets should they develop.

Few avionics systems companies are willing to ignore the current excitement created by optical masers. As an official of one well-known electronics company put it, "We missed the radar business, but we're not going to miss this."



New Antenna

Telemetry-command antenna array made by Technical Appliance Corp., Sherburne, N. Y., has nine high gain seven-element Yagis. Array provides instantaneous choice of polarization modes, elevation and azimuth remote control for two-way communications.



"There shall be wings!" said da Vinci. "If the accomplishment be not for me, 'tis for some other. The spirit cannot lie, and man, who shall know all and shall have wings, shall indeed be as a god." Leonardo's originality is evident in the many sketches and plans for both flying machines and parachutes in his notebooks. Though he was never satisfied with his designs and died before he could bring his work to fruition, his sketchbooks indicate a thorough study of the mechanics of bird flight and his attempts at simulating it. The remarkable da Vinci even designed a helicopter, which indicates that his grasp of aerodynamics extended well beyond bird simulation to concepts of flight we employ today.

The facsimile page presented herewith is from his original book of sketches and observations. Flying Machine models, constructed in exact accordance with Leonardo da Vinci's specifications, are on exhibition in the National Museum

LEONARDO'S FLYING MACHINE DESIGN—1490

ORIGINAL

Daystrom originated the square design for a trimming potentiometer. Since we introduced the Squaretrim® several years ago, it has established an enviable growth curve, and is being specified on more designs every day. The original space-saving square shape, plus the high reliability that results from our wire-in-the-groove resistance element winding technique (another original) sets the Squaretrim in a class by itself. Further, we offer immediate delivery and the widest selection of standard models. Send for catalog.

THE SQUARETRIM® SUBMINIATURE POTENTIOMETER

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

ANDREW

HELIAX

LIFE LINE OF THE TELEMETRY SYSTEM

For the vital telemetry link of the Agena Launch system, Lockheed chose HELIAX. The requirements of this launch complex link, typical of careful missile range instrumentation, illustrate the advantages of HELIAX.

No RF Noise: The unique Andrew connector design captivates inner conductor to outer conductor, eliminating RF noise from sliding connector contacts.

No RF Leakage: The continuous copper outer conductor protects the circuit from other RF signals.

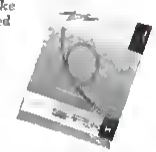
Low Loss, Low VSWR. Insures maximum circuit reliability, minimum signal distortion.

Flexible, Rugged. The corrugated outer conductor of HELIAX makes it the only flexible air dielectric cable. This corrugated outer conductor withstands high crushing forces and heavy vibration.

Easy to Install. Andrew connectors are easily attached in the field, even by inexperienced personnel. HELIAX flexibility makes it much easier to pull into place on the tower and through ducts.

No Corrosion Problem. HELIAX, made of copper, is less affected by corrosive fumes and fluids present in launch areas.

These advantages make HELIAX the preferred coaxial cable for all RF transmission.



Write for HELIAX and Telemetry Antenna Catalogs
P O Box 807
Chicago 42, Illinois

CHICAGO: P O Box 807, Chicago 42, Illinois, Fieldbrook 9-3300
LOS ANGELES: 941 E. Maryland, Claremont, Calif., National 6-3585
TORONTO: 606 Beech Street, Whitby, Ontario, MOhawk 8-3348

Andrew

NEW YORK: P O Box 416, Ridgewood, N J., GIlbert 5-2588
WASH., D C.: P O Box 5807, Wash 14 D C, OLiver 4-2540
BOSTON: P O Box 236, Westwood Mass, DAvis 6-5508

ANTENNAS • ANTENNA SYSTEMS • TRANSMISSION LINES
VISIT ANDREW BOOTH 1502-04 AT THE IRE SHOW, NEW YORK CITY

BELL YHU-1D Iroquois, latest in the HU-1 family to enter Army service.

Helicopters

VERTOL HC-1B CHINOOK

Military Sparks Helicopter Growth Revival

By David A. Anderton

New military orders of four helicopters will set the pace for rotary-wing aircraft development during the coming year.

Two of these orders will buy development on new types: a light and a heavy helicopter for the U. S. Marine Corps.

Two more will purchase off-the-shelf types for two U. S. Air Force missions: missile site support, and support of offshore Texas Towers.

Continuing development and production for nine other helicopters for all the military services will provide the broad base on which the industry hopes to build its future

Biggest support for the helicopter manufacturers traditionally comes from the military services, which underwrite the major portion of research and development in the rotary-wing field, and then buy the production results of that work. Thousands of helicopters on the services' rosters daily perform dozens of tasks. They carry the President of the United States. They move counter-force guerillas against the Communists in the jungles and clearings of Viet Nam. They fight fires in wrecked crashed aircraft and rescue the occupants. They evacuate the personnel of a Texas Tower in the face of storm warnings

But paradoxically, if a manufacturer wants to get high-time data on one of his helicopters, he has to go to a civilian operator. The military just doesn't get much utilization out of any of its aircraft, fixed-wing or rotary-wing, if they get an average of three hours per day, they are considered well-used

In contrast, consider Chicago Helicopter Airways, an operation which is expected to top the combined total of scheduled flights by New York Airways, Los Angeles Airways and Sabena Belgian World Airways early this year. CHA will schedule 165 flights a day for its fleet of seven Sikorsky S-58s and four Bell 47Gs, over a network that covers the airports and a couple of suburbs of Chicago. This works out to daily utilizations approaching 10 hr per helicopter

This is one of the biggest contrasts in the helicopter field today: the services have lots of helicopters, but don't work them very hard, the commercial operators have only a few, but work them to the limit

That contrast shows no signs of changing during the coming years. Only seven helicopters are to be delivered to the scheduled airlines this year. The military services will buy several hundred units of about 10 different types, and will sponsor development of perhaps a half dozen more, to say nothing of the major effort going into the helicopter's close relative, the V/STOL aircraft

Military Buying

The defense budget for Fiscal Year 1963 calls for major expenditures for a large variety of helicopters for all of the services. No comprehensive total is available for either the numbers or the dollars being spent in these procurements, following traditional practices, some of the services specify numbers, some dollars, some neither, some both. Navy lumps its helicopters in with aircraft purchases, somewhat in the style of Army Ordnance practice a few years back which grouped guided missiles with small caliber bullets, artillery shells and other ammunition

The Air Force, which has lagged the

other services in its use and support of the helicopter has requested funds this coming year to buy two different types. One of them will be primarily for support at missile sites, the other will be for support of the offshore Texas Towers. Because of the varied load requirements, the former job probably will be done by two helicopters, one a single-turbine, and the other a twin-turbine type. But the over-the-water Texas Tower support aircraft will necessarily be a twin-turbine type.

Prime contenders for the first order, or parts of it, are Boeing Vertol, Kaman and Sikorsky. Either the Boeing-Vertol 107 or the Sikorsky S-61 design is expected to get the nod for the offshore job.

Air Force continues to buy Kaman H-43B turbine-powered helicopters for Military Air Transport Service's Air Rescue Service which was given the mission of all air rescue, including that at air bases. MATS operates a variety of helicopters to do this task presently and will buy additional H-43Bs to increase its capability in the air base operations.

U. S. Army is probably the biggest supporter and purchaser anywhere of rotary-wing aircraft. Its battlefield support air strength is about evenly divided between helicopters and fixed-wing aircraft. Current numbers of active helicopters in the Army inventory approximate 2,800, with the total for fixed-wing aircraft just above that level.

Budget Request

Army's budget request for 1963 includes $130 million to buy Bell HU-1B Iroquois battlefield helicopters, plus Boeing Vertol HC-1B Chinook heavy assault helicopters. In addition, Army is requesting an unspecified amount to purchase Bell H-13 Sioux and Hiller H-23 Raven light helicopters to fill the gap until the light observation helicopter (LOH) enters service in 1965.

Biggest of all helicopter contracts looming in the future, the LOH program could result in the purchase of several thousand helicopters, as many as 4,500 have been mentioned by Army sources. Thing open to industry in a competition to design a cheap, light, simple vehicle for working at field levels with the troops, the LOH concept stirred one of the biggest reactions yet observed to a request for a proposal.

Every helicopter company submitted designs and they were joined by some manufacturers traditionally in the fixed-wing field. After much delay and suspense, Army awarded a double contract for development of a test quantity to Bell and Hiller. Later, Hughes was made an equal partner in the program's first phases. Under present plans, each of the three companies will design and build five flight vehicles for Army evaluation.

The three competing designs—Bell D-250 (Army designation HO-4), Hiller Model 1100 (HO-5) and Hughes Model 369 (HO-6)—are powered by single Allison T63 turboshaft engines rated at 250 shp. Specifications required a four-place design with a speed capability of 110 kt.

There is some feeling in the industry that Army will not be able to choose a single contractor for such an enormous order as now planned. There is belief that the order will be split, possibly three ways with pieces going to the three finalists. There is also the possibility that Army may not get money for the full program, and that production may never get above several hundred.

Helicopters at Sea

Navy operates two types of helicopters, general utility and anti-submarine. The former type does what the name implies: it ferries admirals to and from their flagships, flies plane guard missions during carrier aircraft launchings and retrievals, and transports critical cargo items. Its job is to work within the fleet, doing anything anybody can think of. The anti-submarine helicopter, on the other hand, has one specific job only: to listen for, recognize, locate and attack enemy submarines.

For Fiscal 1963, Navy has requested funds to buy additional Kaman HU2K-1 Seasprite utility helicopters and Sikorsky HSS-2 Seadragon ASW aircraft. Both these helicopters are currently in volume production, with fleet deliveries of both types scheduled this year.

Navy is also the contracting officer for the Marine Corps, a pioneer in the use of the helicopter and in the concepts of its operations. Marines are building their future vertical envelopment force around three types of rotary-wing aircraft, called simply the new light, new medium and new heavy helicopters. The new light helicopter, which used to be called the ASH, design is intended to carry a squad of fully equipped Marines into battle. The new medium helicopter, which is the Boeing Vertol HRB-1, is intended to carry larger numbers of troops or lighter and more mobile weapons and equipment. The new heavy design, carrying the current designation HRX-(H), will carry the weapons for support of the Marines after the initial assault area has been secured.

Marines will operate this mixed helicopter force off two types of vessels. First of these is a group of eight LPHs, four being converted from CVS aircraft carriers and four being built new. Two of the latter—the Iwo Jima and the Okinawa—are well along in construction. These helicopter carriers will transport the battalion landing teams to battle areas.

The Marines' heavy equipment and weapons will be lifted in from a group of six LPDs converted LSDs (Landing Ship, Dock) which were built like floating drydocks to transport landing craft. The dock area will be covered with a platform to be used for helicopter operations.

Commercial Operators

Scheduled helicopter airline operations are expected to expand during the coming year, but the question of subsidy looms as the biggest problem facing the handful of operators. Subsidy may decide whether or not an airline is able to serve additional stops in the route networks around metropolitan centers.

The key factor in determination of subsidy generally is the operating cost: these costs can't be determined for the new generation of helicopters with any accuracy until they have been in service for a considerable time. The operators can't run up time on helicopters until they have enough of them in service over enough routes to get significant data. And they can't finance enough helicopters or serve enough stops unless they can show the economic solidity of their own operations. So the circle goes, and helicopter manufacturers everywhere are hoping that somebody somehow will be able to break into the cycle.

Cost Prediction

Manufacturers are frank to admit that the only kind of costs they can predict with any certainty are direct operating costs. Indirect costs vary from airline to airline and are dependent on a number of intangible factors.

Consequently, the expected future growth of the scheduled helicopter airlines hangs on too many uncertain hooks now to make predictions of that growth anything but wild guesses. About the only certainty is that the growth will come because the helicopter is the only aircraft that now shows any promise of meeting the requirements of short-range, high-density traffic between cities, or between metropolitan centers and the distant jet airports that serve them.

Even with all the uses of the helicopter in industry, in charter for work or sightseeing, and as executive transports, there are less than 1,000 active registered helicopters in the United States today. Total of registered helicopters in the U. S. last year was 1,081, of these, 651 were active and 430 inactive. The buildup of helicopter strength has been very slow; it approximates 200 a year now, and five years ago was about 100 per year.

Total amount of business done with these commercial and executive helicopters has been estimated at $50 million per year. Number of operators in the U. S. and Canada grew from 193 in 1960 to 265 last year.

Availability of the second-generation gas turbine for helicopter power has triggered a series of investigations to take full advantage of the improved power-weight ratios of the engines. Fundamentally, the helicopter is not a speed demon, the unofficial speed record currently stands at just over 200 mph. The Sikorsky HSS-2 that set the mark is one example of the marriage of second-generation engine and airframe, and as such, points the way toward accomplishment of this speed as routine for cruising operations.

Next Target

Most helicopter engineers are agreed that the next target is a 200-kt. cruise speed. The power is available, and the only thing remaining is to clean up the detail design of the helicopter so that its aerodynamic characteristics will be as modern as its powerplant.

Helicopters have been defined as

NEW YORK AIRWAYS' Vertol 107 is shown flying with United Nations' building behind it

COAST GUARD SIKORSKY S-62 RESCUE DEMONSTRATION

HILLER HO-5 LOH MOCKUP WITH H-23

stall-proof aircraft. This is not quite true, because as helicopter speeds increase, the retreating blade gets perilously close to the stall. At the same time, the advancing blade is working closer to the compressibility zone, and that combination spells trouble. One way to eliminate that trouble is to reduce the operating lift coefficients around the cycle of the whirling blades, that means that the blade loading must decrease. This is done by increasing the number of blades, or the chord of the blades or both. This increased solidity means that the balance between stall and compressibility can be delayed to higher forward speeds. That's why, incidentally, a lightly loaded helicopter can fly faster than a heavily loaded one.

Helicopters are also high-drag aircraft. With a bulbous front so necessary for visibility and the collection of hardware on top of the rotor mast, it is no wonder that the machine has a built-in headwind. This kind of aerodynamic design never would be tolerated in a fixed-wing aircraft.

It has been tolerated in helicopters because until recently, none of them ever went fast enough to worry too much about the drag. The important thing was to get vertical lift, and drag was of no matter whatsoever.

But now, with helicopter cruise speeds beginning to crowd those of the Douglas DC-3, the manufacturers and the operators have realized that their vehicles ought to be at least as clean as that venerable transport. This means that considerable amounts of money and wind tunnel time are going toward drag cleanup of the helicopter fuselage, particularly in the high-drag region around the pylon and rotor hub. This can be seen in visual comparisons between the current gas turbine crop—107, S-61 and HU2K-1—compared with their immediate predecessors. The odd shapes of the fairings at the pylons show the detailed aerodynamic study that went into the refinement of the shape.

Another way of decreasing the lift coefficient on the rotor is to unload the rotor, which means that some of the gross weight of the helicopter is carried by a fixed wing. The Fairey Rotodyne and some versions of the Russian Mi-6 show this. There is considerable difference of opinion on the value of the unloaded rotor among the engineers who work on advanced design. Vertol had an Army research contract to study the effects of adding wings and extra propulsion to the Model 107 and the Chinook. The study results showed that there was a considerable improvement in performance, particularly in high-speed flight, and that there was a major increase in gross weight empty charged to the wing weight and the weight of the propellers used for extra propulsion. Current thinking generally is that for the short-range problem, there are not enough advantages in the compound helicopter of that type to make it worth while.

One ingenious way to beat the stall and compressibility problem of the ro-

rating blades is to design the rotor so that it maintains a nearly constant tip velocity whether in hover or forward flight This is done by letting the blades lead and lag their theoretical positions as far as possible The advancing blade, which normally lags its geometric true position by a few degrees due to drag, is allowed to lag by a much larger angle —perhaps 30 deg or more The retreating blade, which leads its geometric position, picks up extra velocity as it swings through its portion of the cycle and operates at a speed well above the stall. Currently, work on that type of rotor is being done by Bölkow-Entwicklungen in Germany it is being watched with great interest by at least two manufacturers in this country

Rigid Rotors

There has been a revival of interest in the rigid rotor—one which does not have either flapping or lag hinges—sparked by work being done by Bell and Lockheed Bell's approach has been to substitute the rigid rotor for its standard two-bladed form, Lockheed has taken the idea and coupled it with some kind of mechanical gyro system for increased stability Both these developments have sparked interest again in the rigid rotor, and the industry expects that several more developments will appear shortly

Advantages of this rotor are two-fold First, the mechanical parts are so reduced in number that the maintenance headache of a multi-hinged rotor head almost vanishes Second, the rigid rotor offers more in-flight stability and a tremendous center-of-gravity range, something which single-rotor helicopters can always use

Biggest development in the field of VTOL aircraft was the award of a contract to develop the tri-service transport The Vought Hiller-Ryan team, chosen after a design competition that spread across the industry, will build a tilt-wing model under current contracts totaling $21 million, evenly sponsored by the three services Ultimate business on this contract has been estimated between $70 and $100 million

In complete contrast to this is the small amount of funding going to VTOL research and development, an area where most engineers agree there is much room for R&D Test vehicles that have been built and flown in the past have shown dynamic characteristics quite different from the predicted values, and have proved them designers wrong more than once Flying characteristics determined by impartial pilots from National Aeronautics and Space Administration have varied from too much stability to too little and from acceptible flight to dangerous regimes that could be handled only by an experienced pilot

CESSNA'S three entries in the light twin business plane market are the Model 320 Skyknight (top), Model 310G (center), and Model 336 Skymaster

Business Flying

BEECH MODEL 80 QUEEN AIR

Business Flying Regains Note of Optimism

By Erwin J. Bulban

Reductions in field and factory airplane inventories and improvement in the general economy reflected in customer buying moods are signs that 1962 will be a more favorable year than 1961 for business aircraft manufacturers.

Barring any sharp dips in the general business climate, there is even a possibility that the industry will set new records for dollar volumes that would top the 1960 all-time high of more than $200 million.

But some problems and decisions lie ahead for an industry that has more than tripled both dollar volume and unit volume in just a decade. Not the least of them is the possibility of a government anti-trust action that could upset the delicate machinery of factory distribution relationships and require sudden revision of traditional retailing concepts.

Productive Year

With a year of recession largely behind them, most industry executives are inclined to regard 1961—during which unit deliveries slid to 6,778 from 7,585 made in 1960 and dollar volumes, at retail levels, dropped by $30 million to approximately $170 million—as a productive year which provided invaluable lessons in sharpening management skills. Good years during which the industry's growth trend carried even some marginal operations upward through sheer momentum had tended to dull these perceptions.

It was a year of paring the accumulated fat that had gone unnoticed in the good times. Excess overhead—a shop that had been retained, partially for sentimental reasons because it "had always been in the business" personnel who had been kept on for the same reason or because they had a "hot year" several years ago; the extra-plush station wagons that had grown in number almost unconsciously because "someone said we could use them"—suddenly disappeared as closer scrutiny of cost control began.

Unheeded Storm Signals

Failing to heed indicators that warned of impending inventory problems in the distribution outlets and some factories with an over-optimism generated by 1960's record year boosted normal orders and production at the end of 1961.

When sales failed to materialize, inventories piled up. Cessna for example built 200 units on top of earlier scheduled numbers because of distributor/dealer orders in the first quarter. A frantic effort to reduce the flow ensued. Cessna cut production by about half in the second quarter to brake output.

Not only were the sales outlets burdened by a large supply of new and previous year models, but they also were stocked with many high-priced heavy single-engine and light-twin aircraft. Breakdown of the inventory situation is difficult to obtain for the industry, but Piper frankly admitted that its distributors' stocks of new and used aircraft totaled $8 million in the first quarter. Beech also apparently was caught heavily although it is reluctant to discuss details. Cessna said that its distributor and factory inventories were relatively low compared to its competitors, but that industry stocks were so high that the customers who were interested shopped around and it probably lost some who normally would have bought Cessna.

Now the situation is radically different, according to factory personnel. Beech reports that inventories of 1961 and 1962 models are down more than 25% over a year ago, that in fact, the situation is better than it was two years ago. Distributor inventories were down $5 million as of Jan. 1 compared with last year.

Low Returns

Because of abnormally high 1961 first quarter business, first-quarter results this year appear to be low, to the point where the question might arise whether the industry will show a continued drop in business over 1961. But field and factory inventories are now at more realistic levels. Beech reports a 3% increase in orders in the December, January, February period of the current sales year, and Cessna a first quarter that is the second biggest in its history. Cessna adds that its second quarter deliveries will be substantially better than last year's.

Thus it appears that the industry is off to a good start this year on a more solid footing. Also the factories report that orders are coming in at a more consistent flow rate than a year ago, a marked change from the erratic placement then which caused

MOONEY MK 21C

PIPER AZTEC B

frantic shuffling of model schedules as temporarily raised.

It is within this atmosphere of having successfully weathered a recession year, though one which Beech and Cessna still considered their second best year, that industry management considers some possible bad weather ahead in the form of possible Department of Justice antitrust action.

Few will discuss the problem freely because of possible legal complications. Indications are, however, that the government's investigation centers around three of the basic tenets of current aircraft parts and accessories distribution systems: company programs for franchising dealers, the basis of price differentials to distributors and dealers, and the philosophy of protected territories.

Thus far the government has collected documents from eight airframe manufacturers, including correspondence relating to industry meetings and copies of suggested list prices and schedules of discounts to sales outlets (AW Mar. 20, 1961, p. 23).

The government also has interviewed distributors and dealers, obtaining statements from some who have been critical of the system. In some respects the criticisms are believed to be in a vein similar to that unearthed during Congressional investigations of automobile marketing several years ago—that the manufacturers exerted undue pressures on some distributors and dealers in setting quotas and standards for maintaining facilities, and in other operating phases of their businesses.

Industry spokesmen profess no knowledge that the government plans to follow its investigations with a formal suit, and major manufacturers say that they have no plans to change their current patterns. To do so, they point out, would be an open acknowledgement or inference that there was some ground for antitrust action.

Some feel that inevitably, on the basis of similar action by the government in other industries, revisions in current patterns will be forced.

Aero Commander already has taken a step toward revision by wiping out the traditional concept of protected territories for its franchised dealers, substituting instead what it terms marketing areas. Although company spokesmen refuse to discuss the reasons, a source close to management indicated that the move was influenced by the pattern of the government investigation.

The industry continued to make gains last year in the export field—Beech, Cessna and Piper accounting for a total of 1,611 units having an estimated total retail dollar volume of $35.8 million. Penetration of the foreign market by U. S. business aircraft manufacturers is indicated by a five-year summary that shows these three firms have delivered nearly 6,000 new aircraft abroad having a total estimated retail value of $120.3 million. This was done with little or no assistance of the government against competition which often has had government backing.

Growth to large volumes is largely attributed to pay-off of years of developing a groundwork of sales and service facilities overseas against the handicaps of distance, foreign exchange problems and local political situations where stability was the exception, not the rule.

Aero Commander anticipates an increase of 15-20% in unit sales volume over last year, with the pressurized cabin model 680F being the star of the line in dollar volume. High point of the company's product line for the latter part of 1962 will be the Model 1121 Jet Commander, which is expected to fly for the first time in mid-1962. The company states that it has 14 production line positions set with deposits.

Highlight of the Beech multi-engine line in dollar volume is expected to be the new Model 80 Queen Air, an improved Model 65 with more power and a swept tail, plus detail manufacturing clean-up of components. Both the 1961 Queen Air and the light twin Baron proved to be favorites among many members of the Beech distributor-dealer organization, actually to the detriment of other twin-engine models, the twin Bonanza and Travel Air. This led to some unwarranted speculation, company officials said, that these latter types were destined to be pulled from active production. Vice President Marketing Wyman Henry and Vice President Domestic Sales Leddy Greever emphasized that these airplanes will be continued in the line and product improvements are continuing to be reviewed, while holding price lines.

A major event for the company will be initial deliveries of its $12,000-price-class Model 23 Musketeer later this year in competition with Piper's Cherokee and the Cessna 172. Piper apparently aims to take advantage of the time lead it has with the Cherokee and is programming production of approximately 1,000 of the new four-placers for 1962.

Management decision is still pending on choice of powerplant for the new Beech 6-8-place turboprop executive transport. The Turbomeca Bastan was believed to be the choice, but the company may feel that some nacelle details have yet to be worked out satisfactorily. There is still the possibility that the Pratt & Whitney PT6A, the Continental C217-6A, a Boeing or another member of the Turbomeca turboprop family would be in the running, although the lower power ratings of these probably would necessitate scaling down of the current layout, which weighs 12,500 lb. gross. The company has a choice of five basic configurations

U.S. Business & Utility Aircraft Shipments—1961

(Number of Units, Builder's Net Billings—thousands of dollars)

Make and Model	January	February	March	April	May	June	July	August	September	October	November	December	Totals
Aero Commander 500A, B	4	2	9	7	1	0	0	0	0	7	4	0	70
680 F	0	0	8	1	4	0	1	2	0	2	1	0	32
680 E F	4	2	8	0	1	3	0	3	4	8	1	2	35
720	1	0	0	0	0	0	0	0	0	1	0	0	2
	$167	$802	$1 428	$1 105	$583	$1 096	$410	$510	$1 338	$1 282	$431	$529	$11 047
Beech 18 Super	0	5	3	1	2	0	2	4	4	3	2	2	28
33 Debonair	21	11	21	12	11	11	1	0	2	21	23	0	101
35 Bonanza	34	30	27	21	24	25	20	17	15	4	28	27	282
50 Twin-Bonanza	1	0	0	4	3	1	1	2	1	0	1	2	21
55 Baron	13	20	21	22	23	22	18	11	12	0	11	14	190
65 Queen Air	3	0	0	2	2	0	7	0	0	0	0	4	82
95 Travel Air	1	1	0	1	1	7	12	15	0	2	2	4	45
	$3 288	$3 857	$1 928	$2 105	$2 654	$2 801	$1 230	$1 558	$1 950	$1 218	$3 378	$2 885	$37 072
Callair A-5	0	0	2	2	2	0	2	2	1	0	0	0	11
A-6	1	0	1	7	0	0	0	0	0	0	0	0	0
A-7	0	0	0	0	0	1	0	1	0	0	0	0	2
	$7	$0	$30	$99	$18	$8	$13	$14	$1	$0	$0	$0	$183
Cessna 150	29	18	23	16	43	34	35	15	0	33	28	40	344
172 Skyhawk	83	81	83	80	81	80	69	27	18	247	81	42	881
175 Skylark	19	10	1	3	0	0	5	4	0	22	10	0	125
180	31	12	0	11	0	11	10	1	3	0	0	0	130
182 Skylane	84	70	48	19	83	40	40	32	85	10	7	166	575
180 Skywagon	0	0	13	30	32	44	35	10	10	11	21	16	251
210	48	21	18	11	24	15	2	2	12	4	0	2	111
310	20	22	10	10	10	13	12	3	4	3	1	0	138
120 Skyknight	0	0	0	0	0	0	0	4	11	22	10	14	80
	$4 811	$3 800	$2 920	$3 126	$4 891	$3 314	$3 028	$1 611	$2 383	$3 747	$3 506	$4 418	$42 266
Champion 7EC Traveler	0	N.R.	N.R.	2	2	0	2	0	2	1	2	0	16
7FC Tri-Traveler	4	N.R.	N.R.	4	4	2	4	3	3	0	2	1	21
7GC Sky Trac	0	N.R.	N.R.	0	0	0	0	0	0	0	0	1	1
7GCB Challenger	0	N.R.	N.R.	0	10	12	7	4	1	2	1	1	81
7GCBA Agricultural	0	N.R.	N.R.	0	2	2	1	2	0	0	0	0	7
7HC DX'er	0	N.R.	N.R.	0	1	0	0	0	1	0	2	1	5
7JC Tri Con	0	N.R.	N.R.	0	0	0	0	0	0	1	0	0	1
7KC Olympia	2	N.R.	N.R.	0	0	1	0	0	0	0	0	1	4
	$51	N.R.	N.R.	$60	$148	$120	$51	$58	$42	$28	$40	$27	$660
Lake LA-4 Skimmer	1	1	1	1	0	2	2	0	1	0	0	0	9
	$22	$23	$21	$22	$0	$45	$41	$0	$23	$0	$0	$0	$209
Mooney Mark 21	12	12	21	20	22	25	19	16	34	30	20	21	208
	$110	$173	$208	$276	$307	$199	$315	$352	$456	$426	$277	$300	$3 037
Piper PA-18 Super Cub	17	0	13	17	31	22	21	15	13	10	12	7	180
PA-22-108 Colt	55	151	169	112	168	183	72	126	126	85	44	30	1 173
PA-22-160 Caribbean	2	2	3	1	0	0	1	0	0	3	1	0	14
PA-23-160 Apache	1	8	0	14	6	0	1	1	2	3	0	16	14
PA-23-250 Aztec	28	19	21	11	11	11	12	8	11	8	3	1	144
PA-24-180 Comanche	28	11	25	10	18	0	1	0	2	33	16	14	118
PA-24-250 Comanche	52	44	54	38	27	24	21	20	18	10	22	50	401
PA-25-150 Pawnee	20	12	18	24	24	37	20	12	19	0	0	0	200
PA-28-150 Cherokee	0	0	0	0	0	6	0	0	0	3	6	0	20
PA-28-160 Cherokee	0	0	0	0	0	10	12	23	28	54	63	65	221
	$3 158	$2 828	$3 452	$3 706	$2 318	$2 791	$1 784	$1 030	$1 931	$1 820	$2 100	$2 288	$28 385
Totals Aircraft	555	531	527	545	537	527	529	[illegible]	484	878	493	587	6 171
Totals Net Billings	$12 210	$15 582	$12 064	$10 113	$10 807	$10 438	$8 077	[illegible]	$5 329	$11 160	$8 827	$10 486	$124 323

N.R.—No Report.

of varying weight out of a total of 14 design studies that were semi-finalists including a turboprop version of the Queen Air. Basic desire is to maintain the 300 mph. cruise speed considered by management as a key performance requirement. If a lighter airplane is necessary to keep to the specification, it would be one that would have a growth factor to take the larger engine when ready.

In an effort to minimize company expenditure of development funds beyond what it feels is its basic responsibility to the airframe, Beech will expect that major component manufacturers carry their end of the load. It already has indicated to major suppliers that it expects that they will furnish equipments on a consignment basis for the first three airframes.

Piper, probably the hardest hit of the Big Three by last year's recession, expects to show marked improvement of profit margins this year, which in 1961 were down to the lowest level since 1954. Although unit sales overall decreased only 5% from 1960, there was a drop of 35% in sales of the more expensive models including Commanches, Apaches and Aztecs. Higher-than-anticipated starting up costs on the Cherokee at Vero Beach, Fla., also contributed to reduced profits. Major improvements in the Comanche 250, including use of electrically operated flaps and Bendix fuel injection system, and in the Aztec B, which features an extended nose to provide greater flexibility in baggage and cargo stowage without disturbing center of gravity, are aimed at boosting sales of these higher cost airplanes this year to develop improved dollar volumes.

Major Influence

A major influence has been the rapid economic development of many foreign countries, which encourages the use of private aircraft for business use. A number of neighboring countries banding into a common market is expected in turn to have significant effects in future foreign sales programs of U.S. business and utility aircraft manufacturers.

A study of such development is indicated in the arrangement Cessna is concluding with the Argentine government to establish a plant in Mendoza for assembly and manufacture of the model 172.

As Cessna Senior Vice President Del Roskam noted, future development of a foreign market hinges upon direct on the scene manufacturing activities. Otherwise, the U.S. product eventually is hampered or even frozen out by the entry of other manufacturers whose native-built products are put under tariff protection.

Restrictions by European governments on imports of foreign built aircraft keep the numbers brought in far below the actual demand. Customers may be refused permits by their governments if they are not able to prove their need satisfactorily.

Increasing awareness of the market potential within the European Common Market is bound to increase the efforts of European manufacturers to fill this need. If the U.S. manufacturers don't fill the gap in the next few years, they may find it difficult to get in later.

Beech is seriously studying similar programs overseas. One top official said it is most likely that Beech will be in the European Common Market area in some way—in a year or 18 months.

The year past was a year during which the manufacturers made heavy expenditures in retooling and research and development of new models to increase 1962 sales. Cessna costs in the area of retooling and development on new models are estimated at just under $10 million, more than twice the amount it spent in this area in any previous year. The Model 182 and companion de luxe Skylane and the retractable-gear model 210 showed definite improvements with redesigned cabins that were widened and lengthened, floors lowered and large rear vision panels installed. Model 310G, which features upswept wingtip tanks and a modified tail to improve flight characteristics and reduce control forces, was revealed late last year with price reduced by $2,550. The 35 deg. canted tip tanks reportedly will also be fitted to the heavier Model 320 Skyknight next year.

Most radical addition to the line is the new Model 336 Skymaster with fore-and-aft-mounted 210 hp. Continental IO-360-A engines and twin tails on booms extending from the wings. Slated for deliveries later this year, the basic airframe has completed Federal Aviation Agency certification, but engine certification is still pending.

The company's initial venture into the civil helicopter market has been moving slowly—seven demonstrators have been delivered—primarily because of the gradual build-up of dealer capability to properly handle the aircraft. Cessna believes that in the long run this sales method will pay off in increased sales volume over the traditional method of direct factory sales. Current feeling is that the Skyhook will become an important production item in the next six months, its utility capabilities enhanced by soon-to-be-announced accessories including floats, cargo hoist and sling gear giving the helicopter a 1,400 lb. external load capability in static hover flight configuration.

BRITISH BEAGLE 206

European Business Flying Gains Impetus

London—Great Britain, reviving an interest dormant since the late 1930s, joined European manufacturers in a more aggressive invasion of the business aircraft market during the past year.

Including aircraft either in late development stages or actually in production both in Britain and on the Continent, there are at least 21 piston-engine powered aircraft, 8 turbojet powered aircraft and one turboprop airplane competing for prospective business and executive customers.

Coupled with this production increase and its attendant drive for sales is a move, especially strong in Great Britain, for specialized airfields and ancillary services, such as low-altitude weather reporting and improved and expanded air traffic control.

In Britain, commercial pressure from executive aircraft users may soon force the opening to general aviation of a major airport near London which backers predict will provide a stable base for the entire British business aircraft industry.

On the Continent development of export models currently is the prime objective of the business flying industry, with five companies and two teams of two working on turbojet aircraft designs for business and executive use. Included in this race are the Swiss American Aircraft Corp. with the SAAC 23, the Piaggio-Douglas team in Italy with the PD-808, Spain's Hispano Aviacion HA-230, the Saab 105 from Sweden, the team of Potez from France and Heinkel from West Germany with the CM 191. The French Morane Saulnier Paris 3 and the Progetti Costruzioni Aeronautiche (Procaci) F 400 derivative from Italy.

One turboprop airplane, the Potez 840, and a considerable number of piston engine aircraft are either in development or on the production line.

Britain has one turbojet executive aircraft—the de Havilland DH 125 under development as well as a line of piston-powered aircraft from Beagle Aircraft.

Major Developments

Major British developments of the past year include:

- Production phase-in of Beagle Aircraft (British Executive & General Aviation, Ltd.) family of business aircraft led off by the four-place Airedale now on the line, and the Beagle 206 twin undergoing Air Registration Board Certification tests.
- Expansion of the Business Aircraft Users Assn. from what was, in effect, a Royal Aero Club committee to a working organization with 74 companies as participating members and a wide range of objectives.
- Easement of Ministry of Aviation restrictions to advancement of business flying through coordination of military and civil transport air traffic control systems, allowing integration of lighter aircraft in controlled airlanes.

At present, there are 1,549 airplanes on the British civil register. Of this figure, 546 are business and private aircraft and the rest scheduled and charter airliners.

On the basis of surveys conducted by Beagle and the Association, the outlook is for 600 by the end of 1962, 1,200 by 1966, 2,500 by 1970 and more than 5,000 by 1975.

Beagle Operation

Beagle, a subsidiary of Pressed Steel Company, Ltd., now is based at Shoreham, but a Beagle team, led by Peter Masefield, managing director, is negotiating with the Ministry of Aviation for the de Havilland airport and manufacturing facility at Christchurch. De Havilland will phase the facility out in July, as part of the Hawker Siddeley group's contraction of its activities.

Even now, with the first five Beagle Airedales on the line, Masefield says Shoreham is becoming too small for future business. Christchurch manufacturing facilities, although much too large at present for Beagle, are excellent and a good labor force is available, Masefield said. Beagle now employs about 1,500 persons.

Besides the Beagle 206 and Airedale, the company is offering the Terrier and Mk. 11, both Auster derivatives and the latter built for the British Army, and the Wallis WA 116 autogyro still in the development phase.

Two promising designs are the Beagle Miles 218 four-seat executive twin and the Beagle Miles 117 low-wing, single engine sport and touring plane that was born of the 218's components. Both aircraft, being developed under direction of George Miles, technical director, utilize a high degree of glass fiber.

The 218 twin will be offered in two versions, the A and B. The former will be powered by two Rolls-Royce Continental O-300A powerplants of 100 hp. each. The B-model will have two O-300s of 145 hp. The same engines will be offered in A and B models of the Beagle Miles 117.

Masefield is reluctant to discuss the under potential of the Beagle family pending a full shakedown of production problems and trends. Initial concentration on sales will be in the United Kingdom and Europe to build a strong sales and service organization which can later be expanded to the international market. Prices are still being winked out, and, in the case of the Beagle Miles airplanes will not be announced until a production schedule is set.

The Beagle 206 executive twin, which includes toilet facilities is still flying with an A-certificate and has undergone some structural changes, primarily an addition to wingspan, now 36 ft. Beagle has considered strengthening the wing to allow the airplane to take turbine engines, but Masefield considers this for in the future and prefers to concentrate on conventional engines.

The Terrier which Masefield considers has a good trainer trainer potential, is being enlarged and the interior improved. Pressed Steels experience in auto interiors is being used in all Beagle designs. For instance, the Airedale door has a switch which activates a ceiling light when opened.

de Havilland Production

At de Havilland, production is continuing on Dove and Heron, with total sales standing at 527 Doves and 143 Herons. Latest customer for a Dove is the British Civil Guard, first government agency to buy its own executive transport. The company also is pressing its sales campaign in the U.S. and South America.

Emphasis however, is on the DH 125, powered by two Bristol Siddeley Viper turbojets. Its first flight will be made next September.

The cylindrical fuselage is well advanced and wings will be mated to it in the near future. The fuselage will be pressure tested in the de Havilland water tank.

Company now plans to offer the DH 125 in a number of configurations. These include a navigation trainer for military purposes, an unbuilt race plane, a six-passenger business plane and an 8-12 passenger feederliner.

Still to be resolved is the problem of a business aircraft airport near London, but talks re centering on North Holt since enthusiasts have about given up on the long-discussed reopening of Croydon Airport.

Prime movers in this area are members of the British Aircraft Users Assn., which have conducted an active lobby in Parliament for the past six months. Led by its chief executive, Sqdn. Ldr. R. R. Stephenson, the BAUA has concentrated on Northolt, a Royal Air Force station, because it meets the prime requirement: 30 min. by car to central London.

Stephenson contends that without such a facility, business aviation in the United Kingdom is an severely hampered at the start that it can never grow. The BAUA hopes one day to develop Northolt into an airport in a par with Teterboro, N. J., although little but space currently is available.

Closer liaison with the United Kingdom Meteorological Service, which BAUA complains is set up primarily for the civil airlines, also is sought. Forecasts are available to private pilots but not in a specialized low altitude basis unless some sort of personal contact is developed. In many cases, a business pilot flying from, say, Liverpool to Northern Ireland, will be handed a British European Airways Viscount clearance with weather at 25,000 ft.

Continental Activity

On the Continent the common and primary goal of business aircraft manufacturers is to develop and produce executive aircraft, particularly turbine-powered aircraft, for export markets. The United States is a major sales target.

In Switzerland the Swiss American Aviation Corp. hopes to be first with actual handling on the line and is currently planning customer delivery of the two initial aircraft for December. Powered by twin rear fuselage mounted General Electric CJ610-2B turbojet engines of 2,400 lb. thrust each, the six-to-eight place SAAC 23 will have a maximum speed of 588 mph. and a cruise speed of 500 mph. Maximum design cruise range is 2,000 mi. with 7 persons and 310 lb. of baggage aboard.

Marketing plans and basic design

MORANE-SAULNIER MS-885 SUPER RALLYE

have changed somewhat over the past year. The first 25 aircraft probably will be assembled and sold completely equipped in Switzerland as opposed to earlier plans to send stripped-down airframes to the U.S. for installation of powerplants, instruments and interiors.

Cost also has climbed slightly. Original estimates priced the basic aircraft at $250,000 plus another $60,000 for full instrumentation and $15,000 for the interior. Guaranteed price for the first 25 aircraft fully instrumented and with a finished interior has been set at $350,000, delivery in Switzerland.

Prime backer of the SAAC 23 and founder of Swiss American, U.S. industrialist William P. Lear, Sr., hopes to have first two aircraft certificated and on hand for display at next fall's annual meeting of the National Business Aircraft Assn. in Pittsburgh. Lear last month sold his personal holdings in Lear, Inc., to provide capital for Swiss American.

Italy's Piaggio is teamed with Douglas Aircraft Co. in the design and development of a 6-to-10 place low mid-wing executive turbojet designated the PD-808. While the primary design work was carried out in the U.S. by Douglas, final design and production are being done in Italy.

Douglas and Piaggio hope to begin flight tests by early 1963 with initial deliveries later that year. Price of a fully-instrumented aircraft probably will be in the $500,000 range. At least the first two prototypes, which the Italian government is expected to largely underwrite, will be powered by two aft fuselage mounted Bristol Siddeley Viper 20s of 3,000 lb. thrust each. Later versions probably will incorporate the 2,850-lb. thrust GE CJ610-1.

While the overall fuselage length is somewhat less than that of the SAAC 23—39.5 ft.—gross weight is considerably higher at 15,000 lb. Wingspan also is greater at 40.67 ft. Maximum design cruise speed is 520 mph., service ceiling 46,500 ft. and takeoff distance over a 50 ft. obstacle is quoted at 2,770 ft.

The third, and smallest, twin-jet design with space for more than five persons in a cabin interior is under development by Spain's Hispano Aviacion. The six-place executive transport, designated the HA-230, is based largely upon the basic components of the HA-200 Saeta trainer now in production for the Spanish air force. Powerplants are two Turbomeca turbofan engines of 1,540 lb. thrust each.

Range of aircraft which will retain the wing, tail section and tip tanks of the Saeta trainer, is listed at over 1,600 mi. Cruise speed is given as 420 mph.; required takeoff distance is 2,000 ft. at a maximum gross weight of 8,378 lb.

In the field of smaller jets for executive and/or trainer use, two new designs appeared on the scene during the past year—the Saab 105 in Sweden and the Potez-Henkel CM 191. France's Morane-Saulnier also proposed a five-place version of its Paris 2, which has been on the market for the past several years in a four-place configuration. Designation of the new version, shown in the mockup form at the Paris Air Show last summer, is the Paris 3.

The CM 191, an outgrowth of the highly successful Potez-Fouga Magister trainer, is powered by two 1,058 lb.-thrust Turbomeca Marbore 6 powerplants and is scheduled to sell for approximately $220,000. Built as a joint venture by France's Potez and Germany's Henkel, the first prototype is now undergoing flight trials. Although some design changes will be incorporated as a result of prototype testing, the present aircraft has a projected maximum range of 1,318 mi. at an altitude of 29,500 ft. when equipped with two optional wingtip tanks of 85 gal. each. Maximum range without tip tanks is quoted at 976 mi. With the 85-gal. tip tanks the aircraft has a maximum speed of 422 mph. and a cruising speed of 384 mph.

The Saab 105 is designated primarily as a basic through advanced jet trainer for the Swedish air force with a capability of accomplishing close-support roles if necessary. The company also has hopes of marketing the aircraft as a four-place executive plane.

Priced at $210,000 including basic instrumentation, the high-wing 105 is powered by two Turbomeca Aubisque turbofan engines of 1,540 lb. thrust each.

Prototype development is now underway and, if flight trials prove satisfactory, production is assured by a promised order of 100 aircraft by the Swedish air force.

Italy's Progetti Costruzioni Aeronautiche (Procaer) also is planning a four-place version of its F.400 Cobra jet trainer. The present two-place version has a maximum speed of approximately 367 mph. and a selling price of $80,000.

In the turboprop field a potentially strong contender for export sales was rolled out in France last year by Henry Potez in the form of the Potez 840. Powered by four Turbomeca Astazous of 522 shp. each, the 840 is available in either a 24-passenger feederliner or in 8-passenger executive configuration. The aircraft is scheduled to be demonstrated in the U.S. later this year by Turbo-Flight, Inc., of Chicago. Projected U.S. sales price is $500,000.

French companies are offering a plethora of light-plane designs. One of the most successful new entries is the Rallye series manufactured by Morane-Saulnier. Although the first production aircraft was flown only in August the company says it already has more than 500 orders on hand—including 350 from foreign customers—for the two-place MS 880 Rallye powered by a 100 hp. Continental engine and the MS 885 Super Rallye with a 145 hp. powerplant.

New German-built designs on the market include two from Bolkow: the four-place 207 and the smaller Bolkow Jr. Production began last summer and Bolkow currently is turning out six a month. The company has export orders from England, Argentina, Switzerland and Belgium. Sales price within Germany is $13,700. Powered by a 180-hp. Lycoming O-360, the aircraft has a cruising speed of 146 mph.

First German-built prototype of the two-place Bolkow Jr., being built under license from Sweden's Malmi Flight Industry, is expected to fly within the near future.

SWISS AMERICAN SAAC 23 IN PRODUCTION

U. S. Business & Utility Plane Exports

	BEECH		CESSNA		PIPER	
YEAR*	Units	Retail Value	Units	Retail Value	Units	Retail Value
1957	114	$6.7 million	587	$10 million	464	$4.9 million
1958	69	$3.2 million	422	$7.5 million	366	$5.2 million
1959	143	$6.6 million	497	$8.3 million	310	$3.6 million
1960	120	$7.9 million	709	$13.1 million	503	$7.5 million
1961	149	$11.7 million	817	$15.1 million	645	$9 million

SOURCE—Manufacturers.
* Manufacturer's fiscal years, ending Sept. 30.

BRITAIN'S DE HAVILLAND DH-121 three-engine medium jet transport which began its flight test program early this year

International

AERODYNAMICALLY ADVANCED BLINDER twin-engine strike-reconnaissance aircraft, was surprise to Western observers at Tushino.

Soviets Press Air Force Modernization

By Robert Hotz

Soviet Union has placed a high priority on modernizing its air forces and expanding their capability for the 1962-65 period. Despite earlier U.S. intelligence estimates that the USSR had virtually abandoned development of manned aircraft to concentrate almost entirely on ballistic missiles, the Soviets have developed and exhibited a new generation of aircraft across the entire technical spectrum from supersonic bombers to STOL transports, flying cranes and bush aircraft.

Among the major Red Air Force trends are:

- **Pushing the aerodynamic state of the art well past Mach 2** to the limits of aluminum airframe construction. Three new types initially displayed at the Tushino air show in July, 1961 (AW July 17, p. 31), incorporating these Mach 2-plus advances were the Blinder, a twin-engine, rear-mounted turbojet bomber designed as a strike-reconnaissance aircraft equipped with 180 deg photo coverage capability and an air-launched stub-winged missile with a range of about 500 mi.; the Fiddler, an extremely long-range interceptor equipped with both search and airborne intercept radar, twin shoulder-mounted turbojets with double-cone air intakes and long-range air-to-air missiles, and Flipper, a large delta-winged interceptor powered by two turbojets plus a rocket faired between the jet tailpipes and equipped with airborne intercept radar and two air-to-air missiles.
- **Modernizing its air defense** and tactical strike forces from the early supersonic capabilities of the MiG-19 and Yak-25C armed with cannon to Mach 2 interceptors armed with infrared and radar-guided missiles, extended range with belly tanks and all-weather capability, and supersonic light bombers.
- **Modernizing its early jet bomber** force of turboprop Bears and twin-jet Badgers by replacing their bomb bay loads of conventional nuclear weapons with a variety of air-to-surface missiles capable of supersonic speeds and ranges of up to 1,000 mi. and armed with megaton warheads. Both Badger and Bear also have been extensively modified to carry guidance radar for these missiles.
- **Increasing the air mobility** of the Red Army by large-scale production and deployment of new jet transports, helicopters, flying cranes and convertiplanes.
- **Developing a growing anti-submarine** warfare capability with missile and radar-carrying jet helicopters, jet-powered seaplanes and missile-carrying Badger twin-jet bombers.
- **Modernizing the satellite air forces** of Poland, Hungary and East Germany with Mach 2 missile-equipped interceptors and pushing export sales of MiG-19s to Egypt, Cuba, Finland and Iraq.

Strategic Bomber Gap

Sole gap in the technical spectrum of new Soviet airpower appears to be in the long-range strategic bomber area, where the four-jet Bison has apparently dropped out of operational service at the point where its contemporaries the Bear and Badger were modified for their air-to-surface missile capability. Soviets displayed a new long-range heavy bomber with supersonic dash capabilities—the Bounder—at the Tushino show last July, but it does not appear to be in operational service, with probably no more than a service test quantity actually manufactured. It has been under development since mid-1958 (AW Dec. 1, 1958, p. 27).

It appears that the Soviets are placing primary intercontinental strike capability in their ballistic missile force while continuing to get useful service out of their older jet bomber fleet with the addition of air-to-surface missiles of sufficient range to keep these relatively slow aircraft outside the range of contemporary defense systems.

The 200-plane Bear fleet has been rearmed with a large air-to-surface missile that is a modified MiG-21 Mach 2 fighter with a multi-megaton warhead, radar guidance and turbojet power. One of these missiles is carried in a scooped-out belly section of the Bear at about the center of gravity in the old bomb bay section. It has a range of from 1,000 to 1,300 mi. The once-transparent nose that housed the bombardier has now been filled with navigational, search and guidance radar. The modifications of the Bear give it a second-strike capability following the ICBM salvo and an anti-carrier and anti-Polaris submarine capability for long search missions, with its turboprop power plus the ability to deliver homing missiles from ranges outside either a carrier or submarine defense system.

Badger has been modified to play the same role with considerably less range, its scope limited to the European Mediterranean area plus advance Arctic and Pacific bases. It carries a pair of MiG-17s converted to radar-guided air-to-surface missiles under its wings or a single Hound Dog type of missile in a scooped-out belly mounting. MiG-17 has a range of about 800 mi. and the Hound Dog type about 300 mi. About 1,500 to 2,000 Badgers are in operational service.

Bounder's Role Unclear

Bounder's role in the Red air fleet is not clear at this time, although it has been involved in the Soviet's aircraft nuclear propulsion program and has also been used as an aerial tanker. It has been seen in a variety of configurations, suggesting that the service test role is still dominant at this time. There are indications, however, that it may also appear in a long-range anti-submarine

FORMATION OF MODERNIZED TU-16 BADGERS carries Hound Dog type of air-to-surface missile

surface role armed primarily at Polaris equipped nuclear submarines.

Soviets first Mach 2-plus bomber is the 175,000-lb. gross weight Blinder whose initial appearance during rehearsals for the Tushino air show last June caught Western observers by surprise. Western technical experts label it the finest aerodynamic design ever to come from the Soviet drawing boards and give it a vintage year of 1956 for the state of the art incorporated into its current versions. The interval between a 1956 design concept and a flying display of 10 service test aircraft in 1961 gives another interesting yardstick by which to measure the Soviet weapon development cycle. The Blinder utilizes all of the major state of the art improvements known in the Western world short of the variable sweep wing and heat resistant materials required above Mach 2.5.

Blinder has perhaps the most detailed area rule application of any aircraft in the world today. It incorporates conical camber, the "arrowhead" or stretched delta wing and movable turbojet air inlets and has a special heat resistant canopy. All 10 Blinders at Tushino had a 180-deg. ring of large camera ports behind a sharp nose radome. One Blinder was equipped with a stub winged, rocket-propelled missile half faired into the belly, and a special nose section containing an infrared sensor in addition to its radar.

Blinder in its operational version, will apparently be utilized as a strike reconnaissance aircraft capable of searching, locating, recording and striking targets on the same mission. Its unrefueled range is about 2,000 mi., but there are indications that it is equipped for aerial refueling. Range of its air-to-surface missile is about 500 mi. at supersonic speeds. In size and performance it is roughly comparable to the USAF B-58.

Long-Range Fiddler

Fiddler is another new Soviet aircraft that stretches to the performance limits of aluminum construction and is certainly the longest range jet interceptor in the Mach 2 plus class now in service anywhere. It is obviously designed to intercept and attack USAF B-52 type aircraft before they can launch the 300 to 500 mi. Hound Dog missile. Fiddler may be marginal on its intercept capabilities when the B-52H is operationally equipped with 1,100-mi. Skybolt ballistic missiles since it appears to have a capability ranging out about 800 to 1,000 mi. from its base at high subsonic cruise, closing with its target at better than Mach 2 and striking with a pair of radar-guided air-to-air missiles with a range of about 40 mi.

In addition to its large nose-mounted target acquisition and missile guidance radar, it carries a large navigation radar housed in a belly radome to enable it to operate beyond the range of ground-based radar control. Its shoulder-mounted jets have a double-coned intake indicating capability just short of Mach 2.5.

The Fiddler has been under Western observers' "eyeball reconnaissance" for almost two years but its size and speed led them to believe it was a bomber. Consequently, it was carried on NATO books for this period as the Blinder. Only after its true role as a long-range interceptor was revealed at Tushino was this designation switched to the current Blinder and the old Blinder re-designated Fiddler to conform to its fighter category. It also employs the arrowhead wing for an optimum cruise performance at high subsonic speeds combined with supersonic capability up to Mach 2.5.

The third of the Tushino trio that illustrates the current highwater mark of Soviet aerodynamic development is the huge delta-winged fighter designed by Artem Mikoyan and given the NATO code name Flipper.

The Flipper follows the Soviet tradition of combining a delta wing with a conventional empennage. The Flipper uses a 45-ft.-span delta wing with a 65-deg. sweep. It houses a large airborne search and target acquisition radar in a spiked conical engine air inlet for its two large axial turbojets. A rocket engine is faired between the twin-jet tailpipes. Two vertical fins are mounted on the underside of the fuselage below the horizontal slab tail for better control during high angle of attack climbs, when the wing blocks out much of the vertical fin. A pair of two-stage, radar-guided, air-to-air missiles is mounted under the delta wing.

Flipper has been flying for at least two years and has been used by the USSR to set several world speed records including a 1,481 mph. average over a 100 km. closed course with a top speed of 1,696 mph.

At the Tushino air show in 1956 seven new experimental prototypes were flown before the first Western delegations ever invited to witness this event. They included Gen. Nathan F. Twining, then USAF chief of staff, and seven other top USAF generals. These prototypes were the Mikoyan Fishbed, the Sukhoi Fishpot and Fitter, and the Mikoyan Faceplate, all in the Mach 2 fighter class; Yakovlev Flashlight B and C supersonic all-weather interceptor and light bomber; Ilyushin Blowlamp, a supersonic light bomber; and the Antonov An-4 Camp twin-turboprop assault transport.

For several years thereafter it was the fashion in U.S. intelligence circles to opine that this was in fact Potemkin village in which prototypes were flown only to impress the Western observers, and obviously the Soviets had no intention of ever putting these prototypes into production and operational service. At the Tushino air show of 1961, five of these seven prototypes appeared in mass formations with Red Air Force operational insignia and three of these types have been shipped in quantity by the Soviets for operational use in their satellite air forces in Eastern Europe.

The production versions of the Fishbed, Fishpot Faceplate, Flashlight B—now called Firebar—and Camp all showed considerable and sagacious modifications in which many of the prototype faults had been remedied. They also showed a modernization of radar and armament shifting from primarily cannon-armed day fighters to missile-armed all-weather fighters.

The MiG-19 Farmer day fighter which was a relatively new first line Red Air Force fighter in 1956, also has been modernized into the all-weather MiG-19 Farmer B and shifted from cannon armament to missiles. The Farmer B is now the standard inner-defense, all-weather fighter of the Red Air Force, with the Fishbed and Fishpot as the perimeter interceptors soon to be augmented by the extremely long-range Fiddler and the extremely high rate of climb and altitude performance of the Flipper.

The Red Air Force has been engaged during the past three years in a massive

FIDDLER twin-jet long-range interceptor is equipped with search and intercept radar and long range air-to-air missiles mounted on wings

TWIN-JET MIG FLIPPER has rocket engine mounted between the tailpipes.

TU-95 BEAR turboprop powered heavy bombers carry a belly mounted MiG-21 as an air-to-surface missile

KAMOV HOOP convertiplane (left) and Mil Harke flying crane (right) hold FAI speed and payload records respectively.

effort to improve and extend its air defence system to cope with the possibility of a mass assault by USAF's fleet of SAC B-52 and B-47 bombers. In addition to the new generations of all-weather fighters now deployed, the air defense system has been strengthened by expansion and improvement of the radar network, both around the Soviet perimeter and in key target areas, and the deployment of new types of fixed and mobile surface-to-air missiles similar to the U.S. Army's Nike Hercules missile.

In addition to the massive buildup in air defense, the Soviets have continued to modernize their tactical air forces with Fishbeds and Faceplates equipped with belly tanks for extra range and rocket pods under the wings. Firebar, extensively modified and improved in its production versions from the 1956 prototype, also has gone into operational service as a light bomber replacement for the venerable Il-28 Beagle.

Anti-Submarine Forces

In another sharp reaction to a growing U.S. capability, the Red Air Force is taking a strong role in the Soviet navy's development of an improved anti-submarine warfare force. Red Air Force has long supplied most of the operational units incorporated in Soviet naval aviation, but they have been mostly fighters and light bombers.

Now, operational units of twin-jet Badger bombers are being assigned to the Soviet navy. These Badgers are equipped with new search radar and carry a pair of MiG-17, Fresco D, all-weather versions of this obsolescing fighter modified into radar-homing air-to-surface missiles. The use of the Fresco D and the larger and faster Fitter fighters for air-to-surface missiles is another example of the practical Soviet economy of utilizing existing hardware for new purposes where possible to achieve quick operational capability rather than starting from scratch with a new design.

New twin-jet Kamov Harp helicopter, first seen at Tushino in 1961, is also designed for operation from ship-board against submarines, as well as being a ground support vehicle. It is equipped with a large, chin-mounted search radar, two air-to-surface missiles mounted on landing gear struts and a forward firing turret that has two cannons.

ASW Improvement

Soviet navy has also put into operation the Beriev Be-8 twin-jet flying boat which is characterized by Western observers as the worst bit of Soviet aerodynamics seen at Tushino. Bearing the NATO code name Mallow, the Be-8 is nevertheless a major improvement in Soviet capability for ASW patrol planes.

As the Soviets react characteristically to develop defenses against each new U.S. offensive capability, it is certain that their anti-submarine warfare effort will increase with the major effort in the air, using extremely long-range, heavy payload aircraft that can remain on extended patrols for long periods and carry the large airborne power supplies required for long-range search and detection avionic gear and nuclear attack weapons.

Troop Support Aircraft

Red Air Force is approaching an improved mobility for ground troops and their equipment from a variety of angles. Buildup of turboprop powered transports has been steady during the past five years, with the Antonov twin-turboprop An-8 Camp assault transport in limited service for some time. It has been superseded by the An-12, the military version of the Aeroflot An-10 four-turboprop transport. The An-12 has a rear loading ramp that permits vehicle access from ground level and large rear clam shell doors for heavy equipment and paratroop drop.

At Tushino, the An-12 formation landed on the grass field, disgorged short-range army ballistic missiles, their prime movers and firing crews. The missiles were assembled into firing position, used for a simulated firing and then were quickly loaded into the An-12s for takeoff. Although all of the growing Aeroflot jet transport fleet has some military application to the Red Army mobility problem, the fleet of Antonov turboprop transports is the bulk of the direct military air support because of its operational performance from grass fields.

Shorter range mobility for large military loads, including missiles and tanks, has been developed in the two large twin-jet Mikhail Mil designs—the Mi-6 Hook helicopter and the Harke flying crane. Both machines are powered by two Soloviev gas turbines with ratings running from 4,500 to 5,500 lb. of thrust and both incorporate many of the same basic components.

Harke Record

A formation of Mi-6 helicopters landed at Tushino, disgorged missiles and crews who simulated assembly and firing and then dispersed back into the giant helicopters and quickly disappeared over the horizon. The Harke flying crane set a record for its class by lifting 33,000 lb. to an altitude of 7,500 ft.

A third approach to the army's mobility problem appeared in Nicolai Kamov's twin-rotor, gas turbine powered convertiplane code-named Hoop. Its basic concept is similar to the now defunct British Rotodyne using both rotor system and forward driving propellers. The Hoop is obviously in the early prototype development stage and, as yet, there is no indication of how seriously the Soviets will push this technical line.

BLACKBURN NA 39 BUCCANEER LOW-LEVEL STRIKE AIRCRAFT

Britain Seeks to Kindle Export Revival

By Herbert J. Coleman

London—British aircraft industry, still beset by the inevitable uncertainties of its massive regrouping efforts, is slowly slimming itself down to the size necessary for its existence in British and international markets.

With a more flexible policy of expanding beyond the shores of Great Britain primarily through international agreements in the U.S. and Europe, the industry is taking a hard look at the economics of maintaining its present position.

Entwined in the industry's transition is the British government formulation of a vacillating defense policy that has baffled industry planners since 1957. The result has been wastage of manpower and hardware and a lack of industrial direction that has still to be resolved.

An example: the total lack of export sales of the English Electric Lightning fighter, now in line service with Royal Air Force and the Blackburn Buccaneer naval strike fighter, both highly sophisticated weapons.

The two airplanes did not reach production status until long after they were offered as export items. Commonwealth and other nations have shown little interest in the Mk 2 versions of each airplane.

But the winds of change are blowing. The Hawker P 1127 VTOL strike fighter will be purchased by the U.S. Army, the Germans and the Royal Air Force, in small but encouraging quantities.

Vickers-Armstrongs, invading the U.S. with strong technical and sales teams, gained initial orders from Braniff Airlines for its BAC 111 aft-mounted-jet engine transport, the only airplane in production in the 60,000-70,000 lb. gross weight short range jet category.

The TSR 2 strike fighter is being built for the world market, particularly NATO, along with its RAF applications.

In effect, the word in the British industry, passed down from chairman and director level, is to take a leaf from the American book—adopt the hard sell tactic in the world's markets.

Yet industry salesmen have yet to offset a government policy considered by them to be restrictive and uncompetitive. This is the rule under which manufacturers pay royalties to the government on hardware developed with government funds.

There is little likelihood that the royalty policy will be eliminated, or even watered down, Minister of Aviation Peter Thorneycroft told Aviation Week.

"I'm in favor of royalty payments. The government puts money into the industry to reinforce it and should get its financial investment back."

Thorneycroft is considered a prime mover in the joint ventures outside the borders of Great Britain, taking the initiative in salesmanship at the highest political levels. Two projects have been developed by him almost single-handedly, and both have yet to reach fruition.

Of most immediate import is the decision to join France in building a Mach 2.2 supersonic transport. Britain's high card is the ability to provide the engine—either the Bristol Siddeley Olympus 593, or the Rolls-Royce RB 178. Competitive aspect is that the French could go to Pratt & Whitney in the U.S. unless a British decision is forthcoming.

Thorneycroft sees what he calls a "certain amount of gamesmanship" in this area, for he considers the British far ahead in Mach 2 transport research. Main reason for British caution about collaboration, he claims, is to await final reports from the project scientists.

"The real test is whether it (the Mach 2-plus transport) is really any good," Thorneycroft said.

Value of such joint collaboration, he explained, is in sharing the costs of research and development and ultimately increasing the size of the market for supersonic transports. His willingness to enter into such a complex foreign agreement is part of a national philosophy that is leading the United Kingdom, and its aviation industry, more directly into the Common Market.

This also is reflected in the other important project: an eventual European space consortium which would utilize the de Havilland Blue Streak as a first stage, the French Veronique as the second, and a third stage developed under West German leadership.

Behind this is the natural British desire to recover some of the $20 million spent on Blue Streak before it was abandoned as a military weapon. Blue Streak has yet to be launched, though static tests have proved satisfactory.

Official government position is that the launch pad at the Woomera range in Australia is not yet complete. More realistic view is that Blue Streak will not be fired until the 12-nation pact is formally signed, since a single pad failure could wreck the symposium.

Blue Streak research, under the direction of Geoffrey Pardoe, is still under way at de Havilland, but at a reduced pace, to stay with the state of the art. Thorneycroft is positive the European nations will decide to come into the space club by this summer; most important necessity is an overall convention to draw the actual hardware program.

To make it more attractive to the smaller European nations, the work will be split as evenly as possible and various nations will lead design work. West German leadership on the third stage is an example; another is the Italians heading the planning team for the first satellite, a dummy shape that will be fired. Main project will be development of a European communications satellite.

Thorneycroft is convinced that the space club is a necessity for all Europe to allow its scientists to gain knowledge on their own projects rather than remain interested bystanders at the U.S. and Russian achievements.

It is in the field of research and development at home that Thorneycroft has faced heavy criticism, most of which he charges is unfounded. In procurement of aircraft and missiles, the Ministry is responsible for spending about $560 million.

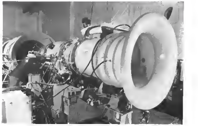
Industry spokesmen claim that the majority of R & D funds goes into the government's own research establishments, the Royal Aircraft Establishment at Farnborough and Bedford, the Royal Radar Establishment and the National Gas Turbine Establishment, all staffed by civil servants.

However, Thorneycroft counters that in Fiscal 1960-61, the Ministry of Aviation put $448 million into research and development projects within the industry and spent another $25 million supporting civil transport developments including boundary layer control and variable geometry experiments. It also spent $70 million in running its establishments.

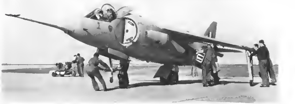
The Minister feels the industry has gained tremendous technical advantages from the government establishments. In addition, the government has put considerable funds into private industry for continuing research into such areas as laminar flow and the variable sweep geometry wing. He added:

"Obviously the industry will press for more, and I hope they get it." This was an oblique reference to what industry leaders consider the main stumbling block, the British Treasury. It still retains final decision on Ministry expenditures despite what has been called a deplorable lack of liaison by the Treasury with both the Ministry and the industry.

The industry has taken heart from government interest in a report on research and development made by a committee on management headed by Sir Solly Zuckerman, chief scientific advisor to the Minister of Defense, Harold Watkinson. The management committee which was established in



BRISTOL SIDDELEY BS 75 TURBOFAN ENGINE



SECOND PROTOTYPE OF HAWKER P 1127 VTOL FIGHTER

1958 under the chairmanship of the late Sir Claude Gibb, made these recommendations after exhaustive interviews with industry leaders

• **Introduction of competition** in both feasibility and project studies for new defense projects

• **Use of holding contracts** to ensure continuity of work while government decisions are being made on the future of defense projects Holding contracts are interim contracts awarded to keep project teams together until a decision is made to continue or drop the project

• **Reappraisal** of the entire pattern of government financed civil and military research

• **Maintenance of momentum of research** projects once they are begun Only major technological or economic changes should be allowed to interfere with their progress

• **Major efforts** to avoid wasteful duplication in research and development among members of NATO and the Western powers

• **Review of the structure** of the scientific civil service

Aside from government research and development expenditures, about $25 million a year is being put into private venture projects, such as the Vickers VC10 and BAC 111 the Westland Rotodyne the de Havilland Trident and the Rolls-Royce Spey engine There is no immediate likelihood that this spending level will increase

In the industry's size reduction initial casualties will, of necessity, be within the design and research teams Two years from now, when Thorneycroft thinks the industry will find its form, design teams will be cut by as much as 20%

First such indication came with a Hawker Siddeley decision to get out of the space research business, eliminating that area from its Advanced Projects Design Team and turning the emphasis on Blue Streak only

Abandonment of the space research plan, in which Hawker Siddeley had heavily committed itself both in the United Kingdom and with the French, was a top level decision spearheaded by Sir Roy Dobson, managing director Since then, Hawker Siddeley has made sharp cuts in its activities, in what Sir Roy calls "tidying up the group"

When Hawker Siddeley took over de Havilland, Blackburn and Folland it inherited 16 establishments and air fields These have been cut to nine The Gloster Aircraft plant has been virtually shut down De Havilland's plant at Christchurch will close in July

With about 100,000 persons dependent on the Group's aviation business Hawker Siddeley is betting heavily on the de Havilland Trident three jet transport, the de Havilland DH 125 executive jet, the Hawker P. 1127, the

Avro 748 turboprop transport and the Armstrong Whitworth Argosy freighter

A VTOL version of the latter, the AW 681, is entered with the Bristol 208 in a competition for a Royal Air Force order Sir Roy thinks the order may not come to pass basically because of cost of developing new airplanes

Hence Hawker Siddeley has concentrated on selling the Avro 748 to the RAF in direct competition with the Hunting Page Dart Herald in a fight that had important political ramifications Hunting Page or more precisely, Sir Frederick Handley Page the firm's chairman has steadfastly resisted merger moves made by both Hawker Siddeley and British Aircraft Corp

Handley Page claims the price has never been right Hawker Siddeley contends Handley Page wants too much money and the issue has not been resolved But the shadow of the government falls over the bargaining table

Government policy is to place its orders with the groups a deal made when Duncan Sandys as Minister of Aviation became architect of the new industrial image Thorneycroft reiterates the policy

Naturally, selection of the planes will be made on technical merits by qualified technical experts" he said "But if it comes down to the fact that both are just as good and can do the necessary job just as well the order will go to the group

After three months of bargaining, the British government finally decided to buy the Avro 748 This leaves Handley Page which employs 8,000 with orders for 20 Dart Heralds, all civil versions The company is negotiating with South Africa for an order for eight Victor V-bombers

At British Aircraft Corp the emphasis is on the Vickers VC 10 family and the BAC 111, billed as a Viscount replacement The VC 10—49 ordered by British Overseas Airways Corp and five by the RAF—faces the more difficult route of the two Despite its aft mounted jet engine an attractive sales point the VC 10 is arriving late on the long haul scene Emergence of a Mach 2 or a Mach 3 transport may severely limit its acceptance

The BAC 111, however, inherits the Viscount market (438 of these have been sold) and is a competitor for U.S. airlines interested in a short haul twin engine jet transport to replace Convair 340 440s or Martin 404s

Sir Geoffrey Tuttle of Vickers feels the supersonic transport market exists on a reasonable basis for whoever is the earliest with a practical design Prestige factor is certain to enter the picture to deaden qualms against cost he says Sir Geoffrey says the RAF tac

tical VTOL transport prospect is cloudy —the Bristol 208 is a British Aircraft Corp design—and, even if the order comes to pass, he claims 30 or 40 airplanes of new design will be most difficult to amortize.

As to the NATO market, Sir Geoffrey reflects the view of many of his counterparts in England and abroad that NBMR-3, the VTOL fighter competition in NATO, may never come to pass. The French have the Mirage 3 Bilzac, a number of countries the Lockheed F-104, the British have the P.1127," he said. "Who really wants a special NATO airplane?" For that matter, Sir Geoffrey has similar views on NBMR-4 the tactical transport competition. As far as the RAF is concerned, he says the size would be about half that desired and range would be severely limited.

Turning to government support Sir Geoffrey contends the government is not doing enough if it wants to retain an industry. He particularly stressed aid for design teams, although agreeing that the size of the industry must be reduced. The question, he said, is at what rate the reduction will be effected.

One of BAC's heaviest losses came from the Vickers Vanguard, due partly to timing of a large turboprop transport in the jet age and partly to phase-in problems of the Rolls Royce Tyne engine. Production was halted last month at a final figure of 43 airplanes.

BAC also inherited, from Bristol Aircraft, the T.188 all steel research plane. Development costs, borne by the Ministry of Aviation, have been pegged at about $30 million. The plane has been criticized for slow development progress, since it is a year behind its programmed first flight, but for limitations of the Mach 2.3 regimes it is designed to explore.

Unlike the North American X-15 the T.188 will land and take off on its own power, two de Havilland Gyron Jr. 20 engines. Thorneycroft defends the cost of development on the basis of its value as a test bed for a stainless steel fuselage and as an airborne electronic laboratory. Its research application will be predominantly in the military fields, Thorneycroft said.

Future design work at BAC now centers on development of variable sweep wing geometry, under the direction of BAC's Dr. Barnes Wallis and of the VC.10 to capture more military and cargo business. One project under serious consideration is to modify the VC.10 as a Skybolt carrier. Vickers claims this can be done with little re-engineering of the clean wing. The airplane is credited as a serious contender for this mission since there are no follow-ons to the V-bombers.

At Short Brothers & Harland, Belfast, the company is concentrating on the Belfast turboprop freighter which, according to Hugh G. Conway, joint managing director, will fly early in 1963. The prototype Short Skyvan cargo transport is nearing completion and is being offered for overseas sales at a price of about $100,000.

In the VTOL field, Short Bros. has a wealth of experience gained from its SC.1 flights, but, as Conway put it, "you can only stay in this field by retaining the lead." To strengthen its VTOL position, the company joined with Lockheed to sell the F.104 with wingtip-pod lift engines to NATO countries. The Belfast also has been submitted as a STOL transport fitted with boundary layer control.

Probably the most stable companies in the British aircraft industry are the two big engine firms, Bristol Siddeley Engines, Ltd., and Rolls-Royce. Export sales have remained high, engines alone set a new 1961 record of $232 million, against $165 million for aircraft.

Best customer for engines was Canada, which spent $47 million. The United States was next with $42 million, followed by France with $28 million and Italy with $16 million.

Prime projects at Bristol Siddeley are its BS.53 Pegasus and the follow-on versions using plenum chamber, or duct, burning devices, the Olympus 593 for a supersonic transport; the Olympus 22R for the TSR.2 and the BS.59 pure lift engine now under construction.

The Pegasus family, about 75% backed by Mutual Weapons Defense Projects funds is aimed at the military market. Dr. Stanley Hooker, chief technical director, said the BS.53 now flying in the P.1127, has reached its 15,000 lb. design thrust and the airplane has, in fact, flown supersonic several times.

Decision to go into the pure lift engine field, dominated by Rolls Royce with its family derived from the RB.108 powerplant for the Short SC-1, has been firmly backed by Sir Arnold Hall Bristol Siddeley's managing director. The BS.59, a fan engine, will operate in tandem with the Pegasus family for example in a light transport in which two lift engines would be installed in the fuselage and two BS.53s hung under the wings.

Philosophy advanced by Bristol Siddeley for beginning development of a pure lift engine in the face of the Rolls-Royce lead, is that specific transport applications may call for the BS.59 and company prefers to have its own engine ready. Designers also point out that the thrust deflecting engine, the Pegasus will reduce the number of lift engines needed, thus offering a more practical airplane.

Development work is continuing on the BS.75 turbofan engine which has a high bypass ratio of 1.75:1 like that of the Pegasus. No application exists aside from the BAC.107, but it has been submitted to Fokker for the jet-powered F.28 Friendship in competition with a derated Rolls-Royce Spey engine. BS.75 gives 7,550 lb. thrust at 0.508 specific fuel consumption.

Design work at Rolls Royce has been accelerated on the engine for a supersonic transport although no metal has been cut. Rolls' chief executive J. D. Pearson concedes that Bristol Siddeley has a lead with its Olympus 593 but adds: "A new airplane should have a new engine concept, and we believe we have that."

Probably in the 28,000 lb. thrust class, the Rolls engine will include an afterburning system of some sort. Compressors will be developed versions of those in the Conway R.Co.42 line and blading will be of stainless steel. It also is likely that the engine's propulsion nozzle will be variable to gain better performance during climb, cruise and low-thrust conditions. Designers are considering a plug nozzle.

Despite Rolls' interest in supersonic engines, Pearson maintains that the company's prime interest must remain in the subsonic powerplant field, with higher bypass ratios as the design goal. The Spey is aimed at 11:1, for example.

Pearson considers the designer's task in highly competitive markets is to keep economics of the customer as a paramount consideration. This embraces fuel consumption, first costs, and spares and overhaul costs.

In the design area the RB.162 pure lift engine deeply involved in NATO competitions, designers are already working on other uses. Pearson disclosed two, is a powerplant for driving ducted fan and fan flap blowing.

Britain's lone helicopter manufacturer, Westland Aircraft, says it is continuing its close ties with Sikorsky Aircraft but has taken on sales and manufacturing rights for the Vertol 107. Latter appears contingent on a government subsidy for British European Airways to operate its proposed London-Brussels-Paris helicopter link with Sikorsky-Westland's only research project —aside from the Saunders Roe SRN.2 Hovercraft — the Rotodyne VTOL transport, finally was cancelled after nearly six years of development work. The aircraft was originally designed by Fairey for British European Airways and two years ago was submitted to Royal Air Force. However, the British Treasury resisted allocation of funding for a 12 aircraft production order, and outside orders were limited to a few letters of intent.

DASSAULT MIRAGE 3C SQUADRON LINEUP

Exports Bolster French Aviation Growth

By Robert E. Farrell

Paris—Evidence of the French aircraft industry's growing force in Western Europe was capped late last year by the French government's decision to underwrite development costs of what may be the world's first supersonic commercial transport—Sud Aviation's Mach 2.2 Super Caravelle.

Official go-ahead on the Super Caravelle project emerged as a climax to a substantial jump in foreign orders. Provisional figures show foreign orders placed during 1961 climbed to a record $380 million, a steeply rising curve from $85 million in 1959 through $230 million during 1960.

Industry's over-all output last year amounted to $480 million, an increase of $30 million from 1960. With a fattened order book and supported by a government with high ambitions in both civil transport and military air power, France's aerospace industry seems headed for an active era.

Moreover, French industry is now solidly oriented to and largely depend on, its export success. The French realize the relationship of their newly won aviation position with their export drive. Satisfied French officials are making flattering comparison with their major rival in Western Europe, the British air industry. Significantly, at least in French eyes, the year ended with the British seeking to share the Super Caravelle program and with the Royal Air Force ordering Nord Aviation's air-to-ground missile, the AS.30.

Export orders during 1961 clustered around Sud's Caravelle jet transport and Alouette helicopter, Dassault's Mirage 3 fighter, Turbomeca and Sneema engines, Nord Aviation's family of tactical and target missiles and, finally, Morane-Saulnier's brisk-selling Rallye sport plane.

About 55% of over-all export orders placed during the year were for civil aircraft compared with 48% in 1960. This trend toward civil markets will increase if France's two new civil aircraft—the twin turboprop Super Broussard transport and Potez's 840 four-turboprop executive-feeder aircraft—win new orders in the coming year.

France's biggest gamble is riding on the Super Caravelle. This year whether or not the French get foreign support—

MIRAGE 3C armament includes Nord AS.20 (left), Nord AS.30 (center), Matra R.511 (on stand, left), and Matra R.530 (on stand, right), unguided rocket packages, gun package, fuel tank and Sidewinder missile (far right)

notably British—Sud will begin cutting metal on the prototype.

Plans call for the first Super Caravelle flight in 1965 and initial airline deliveries in 1968. Idea is to get the Super Caravelle into service as early as possible before U. S. Mach 3 transports. Serious slippage in this timetable could hurt Super Caravelle sales—and the whole French industry.

Despite these hazards, Sud President George Hereil managed to win official support for the project. French government agreed to put $25 million into this year's budget to get the program rolling. Total cost of the project is estimated at $280 million, $165 million to be spent through 1965.

Some observers feel these cost estimates are too low. But once involved, the French government isn't likely to drop the project and besides foreign participation may ease the burden on the French treasury. Bristol Siddeley, whose Olympus 593 turbojet is top powerplant contender, reportedly is willing to help finance the engine development.

Final Super Caravelle design details aren't entirely firm. It is generally expected the 4-engine aircraft will have a take-off weight of 198,000 lb., carry 100 passengers profitably over routes ranging from 1,000-3,000 mi. By restricting its top speed range to Mach 2.2, Sud hopes to avoid most of the technical problems Mach 3 projects will have to solve.

The Super Caravelle's structure will be fairly conventional aluminum. Control surfaces, engine pods and tricycle landing gear will be made of steel or titanium. Sud engineers, perhaps optimistically, expect the Super Caravelle to create no disturbing sonic boom problem.

Most observers view the Super Caravelle venture more as a commercial gamble than a technical one. Provisional price is $7 million.

Sud estimates its breakeven point at 80 aircraft, the market potential at 250 aircraft.

Hereil, aware of the commercial challenge posed by the Super Caravelle project, isn't wasting any time in getting a sales campaign rolling. Already he has obtained a written intention of interest from Panair do Brasil for three Super Caravelles. In effect it gives the Brazilian carrier delivery priority over all future buyers except Air France, which may announce an order this year.

Sud is still short of the breakeven point on its subsonic Caravelle. In early February, with 105 aircraft delivered, the company's Caravelle order backlog has passed 160 aircraft. Breakeven point is estimated to be 225 aircraft.

Moreover, Sud's backlog includes the 20 Mark 10A Caravelles powered by General Electric CJ805-23C aft fan engines ordered by Trans World Airlines but facing cancellation. Also the Caravelle is entering its most competitive period as the Boeing 727, de Havilland Trident and BAC 111 cut into a market area the French twin-jet transport once had all to itself. This 1962 race will determine whether the Caravelle program—already a technical success—will also be a commercial success.

DASSAULT ETENDARD 4M NAVY STRIKE AIRCRAFT

STOL Program

This year will also provide clearer indication as to how successful three other French civil aircraft projects may be. These are Nord's Super Broussard, Henry Potez 840 and Breguet's larger 941/942 STOL transport family.

The Super Broussard program is now entirely in the hands of Nord Aviation. It is possible, moreover, that the twin-turboprop aircraft originally designed by Max Holste may get a new name. Powered by two Turbomeca Bastan turboprops of 1,085 shp. each, the aircraft will carry 28 passengers or about 7,600 lb. of freight. Two versions are being built, the main difference being pressurization.

Nord flew the first non-pressurized production version—the 260—early this year. Company expects to build 10 this year with deliveries to get under way late in the year. Prototype pressurized version—the Super Broussard 262—is expected to fly in September. Nord currently is planning a monthly production rate of four aircraft which means about 30 aircraft are to be built in 1963.

Interest Indicated

No firm orders have been announced for the Super Broussard. However several small airlines in Western Europe, Africa and the South Pacific have indicated interest.

Unlike the Super Broussard, which is getting government support, the Potez 840 is a private venture. Failing to get French support, Potez early this year signed an unusual agreement with the Republic of Ireland. The Irish in fact seem to be putting considerably more money into the Potez 840 than the French government would ever have done.

A clean 18,700 lb. low wing aircraft, the Potez 840 is powered by four 530 shp. Turbomeca Astazou turboprop engines. In feeder version, the pressurized aircraft will carry 24 passengers. Turbo Flight Inc. of Chicago which has U. S. sales rights, has ordered the second prototype, due to fly early this year. Initial prototype flew for the first time in April, 1961, and has logged close to 200 hr. Potez is quoting a price of $500,000, duty paid, for U. S. buyers.

A third French civil transport concept is being tested in Breguet's 941 STOL aircraft. Powered by four Turbomeca Turmo 3D free turbine engines delivering 1,250 shp. each, the 20-ton 941's STOL performance is based on the deflected slipstream, or blown wing principle. A single prototype flew for the first time last June and is continuing its flight test program with no major hitch to date. It's now expected the 941 will better its contractual requirement of landing over a 50 ft. obstacle within 787 ft.

Breguet is also planning a 50-passenger pressurized version of the 941, designated the 942. Company expects to fly the 942 this year with deliveries possible by 1964 if orders materialize.

Mirage 3 Phase-In

French air force, despite its extensive operations in Algeria, is moving ahead with its modernization program. Early this year the 2nd Air Brigade based at Dijon, began receiving the first squadrons of Dassault Mach 2 Mirage 3C interceptors.

Mirage 3 is powered by a Snecma Atar 9B rated at 13,225 lb. thrust with afterburner. Tail rocket unit gives an additional 3,300 lb. thrust for interceptor dashes. Mirage takeoff weight varies between 16,000 and 22,000 lb. depending on mission.

Initial batch of 200 Mirage 3s is on

under by the French air force. In addition to the 3C interceptor version, Dassault is now fitting a Mirage 3E ground-support fighter, which uses Doppler radar for all-weather capability, and a Mirage 3R reconnaissance version.

Close to 500 Mirages may be ordered in these three different operational versions along with a two-seater 3B version for training. Dassault, though losing out in Western Europe to the Lockheed F-104G to date has sold the Mirage to Israel, Switzerland, Australia and to the Union of South Africa.

France also will create a strategic air command this year which by 1965 is expected to be operationally-equipped with Dassault Mirage 4 bombers and armed with nuclear free-falling bombs. The air force is spending $200 million on 50 Mirage 4 bombers with deliveries to begin late in 1963. Two prototype aircraft are flying, the first having been in flight test since June, 1959. A third prototype will fly this spring.

Powered by two Snecma Atar 9 afterburning turbojets, the Mirage 4 has flown above Mach 2 for dashes of more than 20 min. The two place, 50,000 lb. delta-wing bomber is capable of carrying its nuclear bomb, probably a glide-type weapon, to targets 2,000 mi. away without flight refueling. Some versions of the Mirage 4 probably will be used as tankers.

Range may be increased also by using a growth version of the Pratt & Whitney JTF10 turbofan engine. Snecma would develop an afterburner to increase the U.S. engine's present takeoff thrust of 10,000 lb. to 18,000 lb. French would designate the engine the TF106.

Same engine is expected to be used to provide main propulsion for a future VTOL fighter, the Mirage 3V Balzac. First Balzac prototype is expected to fly this June. This aircraft is France's main entry in NATO's VTOL fighter competition, but also is a French air force program.

Smaller in size than the projected production model, the initial Balzac prototype will be powered by eight Rolls-Royce RB.108 vertical lift turbojets and one Bristol Orpheus turbojet for forward flight. Larger version will use Rolls Royce RB.162 lift jets and the afterburning TF106.

French air force missile requirements are being handled as follows:

● Air-to-air: Matra's R.530 two-stage solid propellant missile is standard air force air-to-air missile. The missile is now operational and is being turned out in large quantities. Equipped either with infrared or electronic guidance systems, the R.530 has a launching weight of 430 lb. and is about 9 ft. long.

● Air-to-ground: Nord Aviation's successful AS-30 missile went into quantity production in 1961 and Nord won its first export success late last year with the Royal Air Force. The AS-30, a competitor to the Martin Bullpup, is a supersonic, command-guided missile that can be fired during dive or level flight at either subsonic or supersonic speeds. Total missile weight is 1,110 lb. and over-all length is 14.9.5 in. Its target can be located within a wide area forward of the aircraft.

● Ground-to-air: French requirements in this category are being handled by participation in NATO Hawk program and by air force Nike units within NATO. In addition, Nord Aviation is developing a lightweight ground-to-air missile.

Transport, still handled by Nord's twin piston-engine Noratlas, won't be modernized until early 1966 when initial squadrons of the Nord designed C-160 Transall transport will become operational.

The Transall, a Franco-German joint undertaking, is powered by two Rolls Royce Tyne turboprops, will cruise at 275 kt. with a 16,000 lb. payload. First prototype will fly in France in September and two other prototypes in West Germany late this year.

Still under study by the air force are proposals in a light cargo aircraft competition, a STOL transport capable of flying 950 mi. at 220 mph. with a 3,000 lb. payload. Bidders in the contest are Breguet, Dassault Nord and Potez. Decision, involving 80 aircraft, is expected early this year.

French Navy's modernization program includes building a carrier task force based on two 30,000-ton ships, Clemenceau and Foch. Clemenceau this year will be fully operational and Foch should be in service by 1964.

Navy long-range ASW will be handled by the Breguet 1150 Atlantic land-based aircraft. Atlantic, powered by two Rolls-Royce Tyne turboprops will cruise at 170 kt. Mission time will vary from 12-18 hr. normally. Navy has ordered an initial batch of 27 aircraft with deliveries to begin late in 1964.

NORD 5S.12 ON BREGUET ALIZE

Atlantic is being developed under NATO management as a NATO-wide replacement for Lockheed P2V Neptunes.

In taking delivery early this year of the first of 100 Dassault Etendard 4Ms, the Navy also is assuming its first nuclear delivery mission. Etendard, in addition to its conventional armament is to be armed with nuclear weapons. Its fairly short range—435 mi. maximum with 265 mi. at low altitude—is being improved by inflight fueling using a Douglas developed Buddy system.

French space program presently is being developed on three levels: national, European, and bilateral with the U.S.

Over-all program is coordinated by a new organization established late last year. Called the Centre National d'Etudes Spatiales (CNES), the body is nonmilitary and comes directly under the authority of the prime minister of France.

The organization's 1962 budget has been fixed at $16 million. This sum, over the next few years, is expected to rise to an annual level of $30 million to be divided evenly between France's national space effort and its participation in several European schemes.

On a national level, the French plan to continue their high altitude studies using Snd Aviation rockets such as the Belier, Centaure and Dragon. National program also aims at launching in 1965 of a French satellite weighing 175 lb., using a three-stage launching rocket. First stage will be liquid-fueled and the last two stages solid propellant.

French participation in a European satellite program covers about 20% of the cost involved. This project aims at orbiting a 660 lb. satellite within five years. Britain will provide Blue Streak as the first stage and the French the second stage. A third stage probably will be built by participating nations on joint basis.

ROYAL CANADIAN AIR FORCE McDONNELL CF-101 VOODOO

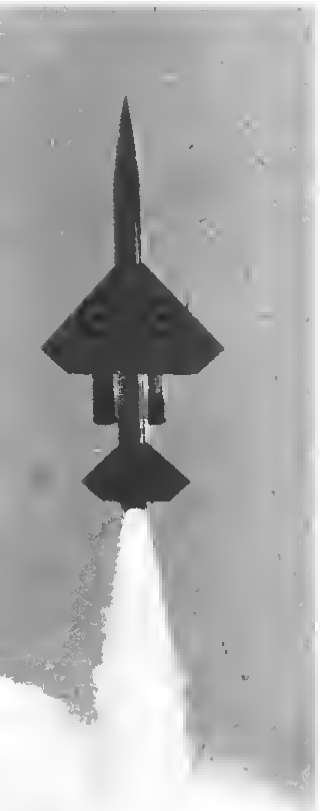
Canada Faces Nuclear Weapon Decision

By James D. Hendricks

Decision on the use of nuclear warheads—long delayed and hotly debated within the Canadian government—may come this year in the wake of a national election.

Approval or rejection of nuclear armament is a major political issue and a key factor in future Dominion defense developments. When the election comes, Canadian defense leaders undoubtedly will press for an immediate yes-or-no resolution of the nuclear question.

Canada operates under the British procedure which permits the party in power to call an election any time it chooses within a five-year limit, usually done when its popularity is at a peak. The Progressive-Conservative Party, headed by Prime Minister John G. Diefenbaker, can wait until 1963 before submitting to a test at the polls, but many observers foresee the election before the end of 1962.



CANADIAN BOMARC LAUNCHING

The present administration has avoided declaration of a clear cut nuclear policy probably seeking definite proof that a decision favoring nuclear weapons will not jeopardize the party's hold on the reins of Parliament. A recent public opinion survey revealed that more than 60% of Canadians interviewed wanted their government to add nuclear weapons to its defense arsenal.

The major opposition, the Liberal Party, likewise has not given a firm indication of its nuclear stand. The New Democrats reaching for major party status and composed primarily of farm and labor factions express equally strong anti-communist and anti-nuclear policies and could exert a solid influence on the balloting.

Meanwhile, defense leaders are impatient for a decision allowing them to acquire nuclear weapons. Many of Canada's newest weapons systems are designed mainly around a nuclear delivery capability and one official says:

"If we don't get nuclear weapons most of our new hardware will be virtually worthless. We'll only be paying lip service to our commitments at home and with NATO overseas."

Nuclear armament of Canadian forces if approved probably would be accomplished with U. S. weapons under the same type of agreement in effect at Thor missile sites in the United Kingdom—U. S. controls the warheads and Great Britain controls the delivery system.

While the nuclear question dominates the Canadian defense picture, some observers see an easing of the problems of anti-United States sentiment and demands from small but vocal groups for complete Canadian disarmament.

A year ago Canadian participation in North American Air Defense Command (Norad) was a prickly subject, but now it appears resolved. A survey similar to the one on nuclear weapons showed a heavy majority supporting both the Norad concept of continental air defense and Canada's role as a full partner in the operation.

Some of this change reflects a gradual fadeout of the anti-U. S. feeling which flared three years ago after cancellation of the Avro CF-105 Arrow program and simmered for almost two years as the Canadian government relied more and more on United States-developed weapons systems and the Dominion's own industry suffered.

"The Canadian people are reawakening to the real need for defense," one official says. "The United Nations failure in the Congo, Khrushchev's belligerency and the Soviets resumption of nuclear testing have caused us to stiffen."

Force Modernization

While pondering a nuclear decision, the government during the last year modernized its tactical and support aircraft fleets and took steps to further integrate and improve its Norad operations. Highlights included:

• **Acquisition** of McDonnell F-101B Voodoo jet interceptors from the U. S. inventory to replace RCAF's subsonic Avro CF-100s. The Voodoo squadrons will be flying with RCAF markings by the end of this year from bases at Ottawa and North Bay, Ont., Comox, B. C., Bagotville, Que., and Chatham, N. B. In exchange for the F-101Bs, RCAF agreed to assume operational and maintenance responsibility for 11 more Pine Tree warning stations on Canadian soil. At present, two of the 11 sites have been taken over by RCAF personnel.

• **Joint agreement** with the U. S. to finance production at Canadair Ltd.'s Montreal plant of approximately 110 CF-104 jets for delivery to air forces of NATO members in Europe, possibly Greece and Turkey. The order carries a price tag of almost $200 million, and deliveries are scheduled to begin in 1963.

• **Re-equipment** of the RCAF's air division in NATO duty in Europe with CF-104Gs. First of a total order of 200 aircraft rolled off the Canadair production line last March. Negotiations were announced to increase the original order of 14 two-seat trainers from Lockheed to 22.

• **Takeover** last month of the Bomarc anti-aircraft missile site at North Bay by RCAF crews. The other Bomarc site scheduled for Canada, at La Macaza, Que., is still under construction. "A lot of people were bitter about our taking the Bomarc and letting the CF-105 die," an officer said, "especially when the Bomarc had trouble in its early days. But it's proven itself now, and for the most part our people seem satisfied with it."

• **Continued construction** of North America's first underground, hardened SAGE (semi-automatic ground environment) center near North Bay. Scheduled for completion next spring, the center will serve as headquarters for the Northern Norad Region and will control Bomarcs, Voodoos and some U. S. air defense systems.

• **Decision** by the government to purchase 190 Canadair CL-41 jet trainers for RCAF basic pilot training. RCAF officers expect the CL-41 to simplify enormously that service's jet training program. Delivery will begin in 1963 and will enable the RCAF to retire its fleet of North American Harvard piston-engine basic trainers that have been used for more than 20 years to train Canadian pilots.

Canada's 1962 defense budget will total approximately $1.7 billion compared with about $1.6 billion in 1961. Spurred by last year's Berlin crisis, the Canadian government authorized an increase of about 10,000 personnel for its services mainly for NATO duty in Europe and these augmentation forces will absorb most of the extra defense funds. RCAF as usual will receive the major portion of the defense budget: an estimated $750 to $800 million.

Size of the budget is another touchy topic in some defense circles. They point out that Canada has one tenth the population of the United States and enjoys a vigorously healthy economy, yet it allocates only about one fifteenth as much for defense. The Dominion's space effort extends only to a small satellite and sounding rocket program and cooperation with the U. S. on research in infrared missile detection techniques. Canada has no missile program of its own.

'About 1970 this may come back to haunt us,' one official said. 'What does a nation without a space program do in the space age?"

Industry Picture

The dearth of space and missile work coupled with a general lull in aircraft development during 1961, has left the Canadian aviation industry picture somewhat clouded. Many top design engineers and scientists including almost the entire team which created the CF-105, have left Canada for jobs in the U. S. and elsewhere. Death of the Arrow program is still bemoaned by many military and industry officials.

Avro, at Toronto, has yet to recover from the Arrow cancellation. Recently, Avro Aircraft Ltd., a subsidiary of A. V. Roe Canada, Ltd., was reorganized as a division of the parent company and renamed the Avro Aircraft Division. Current Avro activity centers on subcontracts for the CF-104 including production of scoops and ducts and wing tip tanks. The division also handles backup orders and spares for this equipment for the European consortium which builds the F-104.

Another major Avro program, the VZ-9V Avrocar flying saucer, has lost its development support from the U. S. Department of Defense. Flight tests of the Avrocar flying saucer last year showed some low-frequency pitch oscil-

lations in forward motion, probably one of the main factors in its abandonment by the U. S. Avro closed its VZ-9V project office in Washington early this year but is continuing work on the vehicle as a company-funded program.

Avro is actively seeking subcontracts on major U. S. programs, but to date has failed to win a bidding competition. The division tried unsuccessfully last year to land the wing box subcontract for the Lockheed C-141 transport. "We keep trying to grab off U. S. subcontracts," a division spokesman said. "We're sending in a stream of proposals through our Washington office."

The major subcontract awarded to A. V. Roe went last year to Orenda Engines Division for modifying General Electric J79 jet engines for the RCAF's CF-104s.

Canadair has fared much better with the CL-104 and CL-41 orders added to continued production of its CL-44 turboprop swing-tail transport. The Montreal company has delivered seven of 10 CL-44s ordered by the Flying Tiger Line, four of five to Seaboard World Airlines and one of two to Slick Airways.

Canadair's other active sales effort has been focused on the CL-41 jet trainer. The aircraft has been demonstrated to NATO air forces in Europe and has been flown by several USAF and U. S. Navy pilots.

Other Canadair work includes development of the advanced CL-41R as a CL-104 electronic systems trainer, Lockheed subcontracts for F-104 structural components, sales of F-104G parts to the European consortium, wings and ailerons for the Bomarc tail cones for the U. S. Army's Hawk missile and curtain wall material for large buildings.

De Havilland Aircraft of Canada, Ltd., at Downsview, Ont., is concentrating most of its efforts on production of its Caribou twin-engine STOL transport. U. S. Army recently placed a $30 million order for an additional 53 planes, bringing the Army's total projected Caribou inventory through 1963 to 127 aircraft. Royal Air Force also has indicated interest in the Caribou, but some British aircraft manufacturers are objecting.

Deliveries of the Caribou and the Beaver and Otter, the company's light transport and utility aircraft to the Ghana air force are virtually complete. De Havilland of Canada estimates that about 20 or 25 Beavers and Otters will be delivered within Canada this year for use by the forestry service and charter operators.

Other de Havilland of Canada projects include a 75-ft.-extendable antenna for use in satellites and sounding rockets and infrared equipment used with the U. S. Army's Mauler missile system.

Germans Begin Rolling Out F-104G, G.91

West German aviation industry, which recorded major technological gains in 1961 despite a series of growing-pain setbacks, hopes to reach its goal of post-war development and production maturity during the course of 1962.

Waging a difficult uphill struggle since its revival in 1956—a struggle its East German counterpart decided to abandon early last year—the industry has made impressive strides by any standard in its drive to regain a leading position within Europe. With its wartime workers and technicians scattered throughout both Germanys, Russia, the U. S. and other areas of the world, and its surviving facilities largely devoted to make-work tasks, the industry began its progress through a series of programmed steps.

Last year marked a production milestone with the phasing in of the Mach 2 Lockheed F-104G interceptor and Italy's Fiat G.91 close support fighter in industry assembly lines. It also was a year of progress on the development front, although a favorite West German project in the aircraft field ran into a series of problems at year end that scratched it from an important North Atlantic Treaty Organization competition for a V/STOL strike-reconnaissance fighter.

Coordination Problems

F-104 production, when fully integrated, will represent Germany's longest step forward thus far. In one move the German industry is advancing from the relatively-simple Fonga Magister jet trainer to a highly-sophisticated weapon system. Most companies of other nations in the program had built or assembled other late-model aircraft before moving into the Starfighter. The project also brings with it the need for a complicated system of coordination among companies of the four countries involved, and it has run into its share of difficulties on both technical and management levels.

The G model, with its all-weather, multi-mission capability, is in some respects a new aircraft, and the industry has suffered through headaches that go with such a development. Introduction of North American Aviation's advanced NASARR fire-control system into the aircraft and onto European assembly lines has called for a series of adjustments and refinements that may necessitate some retrofitting of initial aircraft later.

Licensed production of the General Electric J79 turbojet engine for the aircraft strained present capacity of the firms involved and there have been several shifts in the percentage of work to be handled by the three prime power plant manufacturers. Present breakdown is 44% of the work load by Belgian FN Works, 38% by Germany's BMW Triebwerkbau and 18% by Italy's Fiat and subcontractors, principally Alfa Romeo. An earlier ratio was 48.26% for Belgium, 32.47% for German and 19.27% for Italy.

Despite these difficulties, the first F-104G to be assembled in Germany from Lockheed-produced components was rolled out late last summer slightly ahead of schedule and finished turned over to the air force two months later after flight evaluation. First aircraft to be wholly produced by the European consortium is scheduled to be completed late this year, and manufacture of 949 aircraft for the four nations is to be completed by late 1964 or early 1965.

Using aircraft purchased directly from Lockheed, the German air force hopes to have its initial operational F-104G wing in the field soon.

First G.91 R/3 production by Dornier, Messerschmitt and Henkel is proceeding at a similar pace, and the totals have been boosted. To gain time, 50 R/3s have been purchased from Fiat, plus 44 two-seat trainer versions. Earlier plans called for purchase of only 20 of the latter. German production of the R/3 has been increased from 232 to 294 units. Final aircraft will be completed sometime in 1964 under present schedules.

These two aircraft, replacing North American F-86s and Republic F-84s, will provide the mainstay of the West German air force until at least the late 1960s when, it is hoped, the first V/STOL aircraft will begin to appear.

West Germany, abutting the Iron Curtain and with an obvious need for maximum dispersal, has expressed a requirement for a family of V/STOLs to gain this end—a high-altitude interceptor, a straight G.91 replacement and a supporting medium-range transport. Defense Ministry officials in the past have taken exception to the present NATO competition for a VTOL strike reconnaissance fighter. Ministry feels that current specifications for an aircraft capable of flying at least 250 mi. at a minimum on-the-deck speed of Mach .92 fail to meet West German needs for an effective defense.

Although at one point last fall it debated withholding its crucially needed support from the project—the Defense Ministry has reconsidered in a gesture to NATO cooperation, and there are now indications that the program may eventually shake down along the lines envisioned by Germany, with one aircraft for close support, another for interception.

If the NATO competition breaks out into a final requirement for more than one type of aircraft, Germany hopes to have the VJ-101 ready as a prime entry. If it does not, and if the aircraft proves successful, it probably will be built on a national level.

Production will be on a consortium basis, moving into German facilities as the F-104 and G.91 phase out. Ministry officials hope it will give the country an opportunity to construct an aircraft of largely German design.

A setback was suffered, however, when it was found that specifications for the VJ-101 VTOL fighter could not be completed before the competition's January deadline. The Germans reportedly requested an extension of the deadline but were turned down by NATO officials. The original design, based on the Bell D-188 concept, ran into vibration and control difficulties at an advanced development stage which necessitated major structural and power plant modifications.

Under high priority development by a Messerschmitt-Henkel-Bölkow team for the Defense Ministry, the VJ-101 is being redirected towards the elimination of the swivelling wing tip pods for vertical lift. The new version, probable designation VJ-101D, is built around three Rolls-Royce RB.162 lift engines and two RB.153s housed within the fuselage. The RB.153s will be installed to provide deflected thrust as an augmentation to the 162s in vertical lift flight regimes.

Germany is represented in the competition by two designs submitted by Focke Wulf in collaboration with Hawker Siddeley under terms of a national agreement to work with British industry on development of a tactical VTOL fighter. One proposal designated the P.1161 is powered by a Bristol Siddeley BS.53 deflected thrust engine—as is its progenitor, the Hawker P.1127—plus two augmenting RB.162s. The second is believed to incorporate a BS.75 turbofan engine as its main powerplant and RB.162s for vertical lift.

Focke Wulf, with Weser Flugzeugbau, and Hamburger Flugzeugbau, also is represented by two proposals in the first round of a projected NATO competition for a medium-range V/STOL transport. Its primary design

cells for a pylon-podded BS 53 beneath each wing and six RB 162s in each of two wingtip pods. An alternate design has two General Electric J64 turbojet engines plus RB 162s.

Dornier is entering the competition with an independent entry based on a pylon-podded BS 53 configuration.

The F-104 program is now an official NATO project, as is the G 91. Other NATO production programs to which Germany is committed include the Breguet Atlantic anti-submarine aircraft and the Hawk anti-aircraft missile system. In addition, it is participating in multi-nation production of the Sidewinder air-to-air missile which, while not an official program, bears the loose designation of a NATO-sponsored project, and in the Franco-German Transall 160 turboprop transport project.

Dornier is building the rear fuselage and tail sections for the Atlantic. Hamburger Flugzeugbau is responsible for the fuselage and tail assembly of the Transall and the flight test program for the second and third prototypes. Nord will flight test the first. First flight of the Transall is scheduled for this summer, and Germany and France together are expected to order approximately 200.

In addition, BMW is responsible for 28% of the over-all work in the European licensed-production program for the Rolls Royce Tyne turboprop engine which powers both the Atlantic and the Transall. BMW's partners in the consortium are Hispano Suiza with 44%, and Belgium FN, 8%. Rolls will retain 20% of the work at its home plant.

In the Hawk program, for which European nations involved have pledged over $420 million with another $20 million coming from U.S. aid, Germany will be one of the prime purchasers. Telefunken will be a major supplier of equipments. Germany's Fluggerate-werk a division of Perkin Elmer Corp. subsidiary, is prime contractor in the $30 million Sidewinder production program.

In a common European space program, Germany will play an important role, both in finance and development. Under present plans, Germany will be responsible for the third stage of the three-stage vehicle and hopes to gain a development jump in this field by forgoing conventional liquid and solid propellants in favor of a more exotic second-generation fuel. Prime developer would be Bölkow Entwicklungen, which has evolved into a major West German military and industrial research and production arm since its formation in 1956.

German industry has been proceeding independently on a wide range of projects to fit the nation's needs—low-altitude infrared detection devices as a case in point. To fill a commercial void, light aircraft, such as Dornier's Do 27 and Do 28 and Bolkow's growing family of light aircraft, have been developed and have sold well.

The Cobra wire-guided anti-tank missile system another Bölkow development, has been proposed in the past to both the U.S. and NATO as a standard infantry weapon. Weser Flugzeugbau is constructing production models of a two-place high-altitude powered glider, the equivalent of a small-scale Lockheed U-2, designated the DFS 582. Officially described as a weather and radiation research aircraft and under the sponsorship of the Ministry of Transport, the DFS 582 had an original design specification for a four-hour-plus endurance at 60,000 ft. It is powered by a 3,000-lb.-thrust Pratt & Whitney JT12A-6 turbojet engine for take-off, climb and powered approach for landing.

Perhaps an index to the strides West German industry has made in line with the expanding national economy is contained in Messerschmitt's annual report for the past fiscal year. The company recorded a net profit—$255,000—for the first time since the close of World War II, announced a 9% dividend payment to stockholders and reported that "apart from a few matters the effects of the war and post-war years have been overcome."

Smaller Nations Share Major Programs

Geneva—Aircraft industries of Italy, Sweden and Holland are making impressive strides along a broad development front within the increasingly cooperative framework of Western Europe while looking towards the potential of an expanding export market to maintain their impetus.

Multi-nation production projects are providing a stable financial platform and technological opportunities for companies in Italy and Holland, which are designing new hardware to meet a variety of needs—from executive jets to V/STOL fighters and transports. Neutral Sweden is advancing at a similar pace with a new fighter, trainer and ground effect machine coming off its design boards and into development.

Holland and Italy are represented in the current North Atlantic Treaty Organization competition for V/STOL aircraft, and companies in the two countries are busily completing other designs for both the commercial and military markets. Sweden's Saab Aircraft Co. is working on a follow-on to its supersonic Draken J35 series the Saab 37, with performance figures similar to those laid down in the U.S. for the bi-service TFX competition. Major differences are a lower gross weight—about 25,000 lb. for the J37—and absence of requirements for a sustained ferry range.

As a neutral, Sweden must operate essentially alone. Within the NATO framework, consortium production is playing a major role in the activities of primes and subcontractors alike and either Germany or France is bearing the major load in most instances. Italian companies are active in consortium projects for European manufacture of the Lockheed F-104G interceptor and the Hawk ground-to-air anti-aircraft missile. Dutch companies are involved in the F-104, the turboprop Breguet Atlantic 1150 ASW patrol aircraft the Hawk and the Sidewinder air-to-air missile system.

Aside from Germany and France, other countries represented in these programs include Belgium for the F-104, Atlantic, Hawk and Sidewinder, and Norway and Portugal, both of whom are active in the Sidewinder effort.

Within Italy, Fiat is competing actively in the NATO competition for a V/STOL strike reconnaissance fighter with a follow-on to its G 91 close-support aircraft that is in operational service in the German and Italian air forces. Support for the aircraft, designated the G 95C, and its chances of success were heightened when the West German group of Messerschmitt, Heinkel and Bölkow joined as a partner in the proposal after its own design fell behind schedule.

Companies participating in the parallel competition for a medium-range V/STOL transport include Italy's Agusta as a prime bidder and Meccaniche Aeronautiche Meridionali Aerfer as a member of a Bristol Aircraft Corp. consortium.

In addition to its V/STOL design, Fiat is currently completing production of 50 G 91s for Turkey and Greece supported by U.S. mutual aid funds and a batch of G 91 T/1 two-seater trainer versions on order by the West German air force. Fiat also expects an Italian air force order for the T/1 and is building a prototype G 91 T/4 as a trainer for F-104 pilots. Development of the prototype, incorporating essentially the same electronic equipment as that carried by the Starfighter, is being sponsored by the Italian government, and Fiat hopes to find markets among other European countries equipping with the F-104—Germany, Belgium and Holland.

In a parallel development, also under government sponsorship, Aeronautica Macchi is developing an F-104 trainer version from its basic two-seat jet trainer, the MB 326, and will compete with Fiat for the available market at home and abroad. Designation of the aircraft is the MB-326G.

Prime contractor for the 182 F-104Gs scheduled to be built in Italy under the consortium production program is Fiat, with Alfa Romeo as a major subcontractor for the General Electric J79 powerplant. Fiat, last company to join the airframe consortium, expects to deliver its first F-104 in July. The initial aircraft will be assembled from Lockheed-supplied components, with Fiat phasing in its own production program during the course of the year.

Holland's Fokker, another major F-104 contractor—it has final-assembly responsibility for components manufactured by a number of companies—already has rolled out its first aircraft of the series. Components for the initial five Fokker-assembled aircraft are being supplied at directly to Fokker by Lockheed. Roughed-out components for another 25 will be shipped to the respective European manufacturers by Lockheed, finished and then funneled into Fokker for completion. The 31st of the 375 aircraft assigned to the Fokker group will be assembled from European-built components.

In another consortium venture, the firm is building airframe components for the Breguet Atlantic ASW aircraft. Letters of intent to purchase the aircraft, which is now in the prototype flight test stage, have been sent to Breguet by the West German and French governments and others are expected to follow.

Fokker also is represented in the NATO V/STOL competition for a strike reconnaissance fighter in a joint proposal with Republic Aviation Corp., which holds 33% of the Dutch firm's stock. The design, a variable-sweep-wing aircraft with a Mach 2 plus capability, will be built largely in The Netherlands if selected by NATO for production.

The company's entry in the transport field, the turboprop F-27 feeder liner, has resulted in orders for 120 aircraft thus far—plus another 89 that Fairchild has built and sold under a license agreement with Fokker. The Dutch firm also is planning a stretched version of the aircraft. If orders are sufficient, Fokker has hopes of maintaining the F-27 line at the rate of two and one-half aircraft a month over the next 5 6 years.

In Sweden, Saab is working on a number of projects in several areas, the newest being the Model 37, which is designed to meet a Royal Air Force requirement that its next combat aircraft have a three-mission capability—ground support, reconnaissance and intercept. Initially, the Saab 37 would be used to replace the J32 Lansen attack fighter during the late 1960s.

Present production is geared to the Draken J 35 fighter series. Latest of this type, the J 35F, has a Mach 2-plus capability and will be equipped with Swedish-built Hughes Falcon air-to-air missiles plus a Saab-designed fire control system. The Swedish air force has announced plans to order this version in quantity. Earlier versions of the Draken have been in operational service for the past two years, and, including all versions, Saab expects to produce well over 700 of the series.

The air force also is sponsoring development of a five-place twin-jet multi-purpose aircraft, the Saab 105, and says it will place an order for 100 production airplanes if the prototype meets requirements.

On the export side, Saab has found a sustained market for its Safir 91 primary trainer and has reached agreement with Austria, a fellow neutral, for the sale of sufficient J 29F Flying Barrel fighters and spares to equip a single squadron. To aid the small aircraft industry in Austria, it may be assembled there.

East Europe's Export Drive Runs Into Snag

By Edith Walford

Geneva—East European aviation industry's recent efforts to gain a foothold in Western markets as a much needed outlet for its increasing range of light aircraft and accessories has yet to meet with substantial success.

Obvious, and prime, reason for this is increased political tension between East and West that has automatically resulted in economic restraint on both sides. Another factor, which indirectly influenced the aviation industry in all of Eastern Europe, was East Germany's sudden cancellation last spring of all major aviation projects in the country. Principal casualty was the East German Type 152 four-engine medium-range jet transport and its power-plant, the 7,260-lb.-thrust Pirna 014 A-1 turbojet engine (AW Aug. 21, p. 72).

Elaborate facilities for the two projects had been established at VEB Flugzeugwerke, Dresden, and VEB Entwicklungsbau, Pirna, by the time they were scrapped as part of the government's retrenchment program to overcome persistent labor shortages and economic problems.

Despite this setback, other East European nations are making development and export advances in several directions. The Czechs are working on a tilt-wing V/STOL export design, the Poles have developed a short-range feeder transport. In another area, the Czechs are planning a series of light aircraft for the 1965-70 Fourth Five Year Plan period and a turbine-powered helicopter as well.

East Germany's Type 152 turbojet transport represented that nation's first attempt to establish an aircraft industry of its own following license-production between 1956 and 1959 of about 100 Soviet piston-engine Il-14 transports.

Cancellation of the Type 152 also adversely affected East German Deutsche Lufthansa, the national airline. Largely for prestige reasons the airline planned to introduce its first turbojet services with initial 152 production aircraft scheduled for delivery late in 1962 or early 1963. Instead, the East German airline must now continue to depend on Soviet-built equipment or order the aircraft best suited to its needs elsewhere, even if this means turning to Western manufacturers. Other non-Soviet Communist carriers have recently made such a move or are contemplating it, but East Germany is much more under direct Kremlin influence and whether such a move would be allowed is questionable.

LOT, the Polish national airline, also has had to abandon its original plan to introduce its first medium-range jet services with several East German Type 152s. Russia's Tu-124 medium-range design has since replaced the 152 as LOT's choice among several other contenders for the order, which is still pending.

The Polish carrier is considering the 20-passenger MD-12 piston-engine feeder transport built by the Instytut Lotnictwa (Aeronautical Institute) of Warsaw as a replacement for its older Il-14s and Li-2s now serving LOT's domestic routes. The MD-12 is powered by four 320-hp. air-cooled Polish Narkiewicz engines. Using only about 79.2 U.S. gal. of fuel for all four engines, LOT engineers say MD-12 operations are exceptionally economical. Maximum takeoff weight is approximately 16,500 lb., cruise altitude is 6,188 ft., maximum ceiling 13,120 ft.

First prototype flew in 1959; the second underwent modifications last fall involving improved cabin insulation and a change in engine exhaust location to meet LOT's requirements.

Like all other Soviet bloc countries, Polish aircraft industry's activities are restricted to licensed production of a number of Russian light aircraft, a few purely Polish designs in the same field and the development of a series of high-performance sailplanes, a sphere in which the Polish industry has long since established a good reputation. More recent small Polish aircraft developments based on Russian design include:

- **PZL-101 Gawron** four-passenger utility multi-purpose aircraft, the Polish version of the Russian Yak-12. The PZL-101 completed its flight tests in the spring of 1958 and has been available for export since that time.
- **PZL-102 Kos** single-engine monoplane.
- **PZL-104 Wilga** all-purpose aircraft, the latest in the PZL series.

All three aircraft are built by W.S.K. Wytwornie Sprzetu Komunikacyjnego, Warsaw-Okecie.

The side-by-side two-seat PZL-102 is being used extensively by Polish aero clubs for training, sport flying and touring. A limited number of the fully aerobatic version powered by an air-cooled 90-hp. Continental C-90 engine rather than a 65-hp. Narkiewicz WN-1 engine which powers the trainer, have been sold abroad.

Two powerplants are available for the PZL-104 Wilga model, which is designed ultimately to replace the PZL-101 Gawron: a 180-hp. Narkiewicz WN-6 or a 220-hp. Narkiewicz WN-6R engine. Approximate maximum takeoff weight is 2,530 lb., cruise speed is 100 mph., range 620 mi. and maximum ceiling about 16,500 ft.

The all-metal TS-11 Iskra mid-wing, cantilever monoplane, designed in 1957-58, is aimed at replacing the TS-8 Bies military trainer. Built by Osrodek Konstrukcji Lotniczych (Aircraft Construction Center) Warsaw-Okecie, the TS-11 now is partially is completing its flight trials in Poland. Powerplant is to be a 1,300-lb. turbojet engine of Polish design although provision is made for a 2,000-lb. thrust version.

W.S.K. Works at Swidnik, Poland is concentrating on the manufacture of the SM-1/600 series, the Polish version of the Russian 2-3 seat multi-purpose Mi-1 helicopter.

Polish air force received some of the first production model SM-1s to come off the line in the spring of 1956 and large quantities have since been delivered to the air force of other countries, including East Germany and the Arab states.

New Small Aircraft

The Czech aircraft industry, most important producer of light aircraft and sailplanes among the East European satellite countries, is concentrating upon the design of a new range of small aircraft to be made available during the next 1965-70 period of its Fourth Five Year Plan. It also is planning to move into the turbine-powered helicopter field for domestic use and export in the late 1960s.

Replacement for the Czech high-wing L-60 Brigadyr utility aircraft and a small two-seat helicopter for postal services in remote areas is included in new vehicles being developed.

Czechs reportedly also are working on the design of a piston-engine V/STOL tilt-wing light aircraft for use over the same 1965-70 period (AW Sept. 18, p. 23).

Omnipol, Foreign Trade Corp., the Czech government agency responsible for export sales of light aircraft and associated products, reported at the Third International Brno Trade Fair last fall that a decision had been reached to hold off on production of the industry's new, heavier HC-3 helicopter series, at least for the time being. Nor will any appreciable numbers of the HC-3's predecessor, the HC-2 Heli-Baby, be produced at the Moravan Aircraft Works, Ostrokovice, until sufficient orders are received for either or both to warrant quantity production.

Japan's Aircraft, Missile Industry Shows Modest Increase in 1961

Tokyo—Japanese aviation, lagging behind the growth rate of the rest of industry, made modest progress in 1961 in its long-term rebuilding program.

Total value of production rose to $755 million, an increase from 1960's $668 million and 1959 and 1958's $551 million. Overhaul work constituted a third of this value compared with 25% the year before and 20% in each of the two previous years. Total 1961 investments climbed to $66 million, from $55.5 million the year before.

In manufacturing, the most appreciable gain came from production of components and accessories—the value of which more than doubled from $11.3 million the year before to $28.7 million in 1961.

Only 99 aircraft were produced, all for domestic consumption and mostly for the Japanese Self-Defense Forces. Helicopter production amounted to 57 of this total, followed by 30 jet aircraft and 12 piston engine planes.

Japanese aircraft production has been falling steadily since the postwar peak of 227 units in 1957 because military orders have decreased and the civilian market hasn't taken up the slack. Currently, the industry appears to be in a lull between the production generated during the late 1950s and that anticipated within the next year or so. Society of Japanese Aircraft Constructors estimates that total production value in the industry will rise to $90 million in 1962, $109 million in 1963 and $112 million in 1964. After 1964, the Society specialists, production may fall off due to fulfillment of military orders.

Although most units were produced for civilian use in 1961 ($38) than in 1960 ($15), military procurement still led the way with 61 aircraft. From present indications this trend will continue with domestic civilian demand pushing ahead slowly. After the 1964 peak, the Japanese industry hopes that civilian demands will replace some of the military procurement and anticipates that it may be able to begin exporting then.

Major Japanese aircraft projects currently under way in:

- **F-104J and F-104DJ.** In April 1960, Japan and the United States agreed to the manufacture of 180 Lockheed F-104J jet fighters and 20 F-104DJ trainers for the Japanese Self-Defense Forces. Of these all the trainers and 20 of the fighters will be built in the U.S. The other 160 aircraft will be manufactured by Mitsubishi Heavy Industries. Reorganized Ltd., the prime contractor, and Kawasaki Aircraft Co., the subcontractor. U.S.-manufactured aircraft began to arrive in Japan last month. They are being reassembled by Mitsubishi and will be delivered to the Self-Defense Forces this month. The first Japanese-manufactured F-104J is scheduled for early 1963 with completion of the order planned for January, 1965.
- **YS-11.** Nihon Manufacturing Co., Ltd., a joint government-private enterprise, is developing the YS-11, a short-haul transport equipped with two Rolls Royce Dart RDa 10/1 turboprop engines. The medium range transport will carry from 52-60 passengers. First prototype will make its initial flight in May, 1962, and a second prototype is scheduled for test flights later in the year. Delivery to domestic airlines is expected early in 1964.
- **Helicopter production.** Several Japanese firms are preparing to manufacture U.S.-designed helicopters for military and civilian uses. Mitsubishi will produce Sikorsky S-61 and S-62s. Fuji Heavy Industries Ltd., will build Bell HU1Bs. Under current negotiation is an agreement between Boeing's Vertol Division and Kawasaki Aircraft for production of Vertol 107-2 turbine helicopters.
- **Aircraft Engines.** Ishikawajima-Harima Heavy Industries is producing General Electric's J79 jet engines for installation in F-104Js and T58 turboshaft engines for helicopters.

Ishikawajima also is manufacturing the J3 turbojet engines with a static thrust of 2,645 lb. for the Fuji Heavy Industries T1B jet trainer. This is the first aircraft engine developed in Japan since the war and has replaced the Bristol Orpheus engines previously used in the trainers.

Japanese rocket production continues on a comparatively low key. Three major industrial complexes are involved in the rocket production—Fuji, Kawasaki and Mitsubishi.

- Fuji's AAM-2 infrared, air-to-air missile is scheduled to enter service with the Self-Defense Forces next year. The company also has designed and developed the Kappa series of high-altitude sounding rockets.
- Kawasaki developed the MAT anti-tank rocket. MAT is wire-guided and intended for use by two-man infantry teams or by helicopters.
- Mitsubishi is developing the TMB-0 surface-to-air missile, the TSAM-1 surface-to-air missile which eventually will incorporate a command guidance system, and the TLRM-2 which is a liquid-propelled surface-to-air missile weighing 528 lb. and 10 ft. 9½ in. long.

WANTED
USED HELIOS

HELIO COURIER...... ALIAS USAF L-28-A

REWARD for used Helio Couriers: original owners of 1954 models are hereby offered their full purchase price, less only the cost of new engine replacement and airframe factory overhaul. Other models will be purchased at prices depending upon their condition, generally for aircraft in comparable condition the *older* your Helio the *higher* the percentage of your cost we can offer.

WHY? An 8 year outstanding safety and performance record has created an unusual demand for the extra value of the added structural and STOL features incorporated in no other (non-Soviet) aircraft. All current new production is now required to meet U.S. military needs. Like the classic airliners still in service after a quarter of a century, the oldest Helios still retain decades of dependable service life. Replacement production costs continue to rise faster than depreciation from age alone.

WHAT IS STOL? By accepted European standards STOL (Short Take-Off and Landing) means ability to land and take-off fully loaded between 15 meter (50 foot) high barriers 200 meters (656 feet) apart.

TO BE PRACTICAL: we believe a STOL airplane must also be capable of operating on an open area of approximately 400 feet by 100 feet (less than one acre) at sea level under conditions ranging from *no wind* to cross winds of 25 knots with severe turbulence.

LITTLE KNOWN FACTS: The Helio Courier is the only aircraft in the United States which meets these standards. The Courier also not only can maneuver and land safely at speeds around 30 mph but also can cruise well over 160 mph—*making it the fastest four or five place single engine airplane with fixed landing gear known to be* in *production anywhere* in *the world.*

WHO WANTS USED HELIOS? Since all current production is required to meet U.S. military needs, many business executives who cannot afford to fly in anything but the best pay more for *used* Helios than for other *new* aircraft of lighter construction.

THEREFORE: we will buy used Helio Couriers in accordance with the offer above as rapidly as we can completely rebuild and resell them...with new engines and the assured equivalent of new factory airplane condition, and as long as new Helios remain in short supply.

HELIO AIRCRAFT CORPORATION
NORWOOD, MASS.

Circle Number S-1 on Reader Service Card

Environmental Test Equipment Humidity Chambers Vibration Units Hyd Test Stands; Hi-Pressure Decision & Victor; Radial Plate Temp. Oven; Flowmeters Dynamometers; Oilfacers Motor Generators Beryllium Tensile & Compression Testers Bought Sold Trade-Ins

A & J MACHY CORP
130-32 JACKSON ST BROOKLYN 11 N Y
EV 8-3277

Circle Number S 2 on Reader Service Card

SERVO ENGINEER'S HANDBOOK
DAYSTROM Inc. Transicoil Div. Dept. A W Worcester Pa. 172 pages. $3.00
This guide to the application of servomechanisms deals with the individual components and how to use them, although basic theory is presented the overall treatment is practical rather than classical. There are eight chapters, foreword appendix of diagrams, and 58 major equations.
Send check for $3.00 or P.O.

Circle Number S 3 on Reader-Service Card

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication
Send to office nearest you
NEW YORK 36: P. O. Box 12
CHICAGO 11: 645 N. Michigan Ave
SAN FRANCISCO 11: 255 California St

FOR SALE

Executive DeHavilland Dove—zero time engines—low time airframe—all mods completed. New interior exterior. FS-8171 Aviation Week.

1960 Super G Beechcraft—total time 800 hours—convertible executive—5 seat to 9 place high density seating. FS-8424, Aviation Week.

Grumman G44 Super Widgeon—total time 1,389. Offers invited. FS-8128 Aviation Week.

Your Inquiries to Advertisers Will Have Special Value,
—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU

MOVING? SEND FOR BOOKLET

A free 16-page booklet prepared by Burnham Van Service, Inc can give you helpful work-saving, cost-saving pointers on how to organize your move from city to city when you change jobs. How to prepare to move tips on packing, a helpful inventory checklist of things to do are among the topics included. Write for your free copy. No obligation. C. E. Swann, Burnham Van Service, Inc., 1634 Second Avenue Columbus Georgia

Circle Number S-4 on Reader Service Card

OXYGEN EQUIPMENT
ZEP AERO Sales and Service
Phone Spring 2 1421 El Segundo California

Circle Number S-5 on Reader-Service Card

WHERE TO BUY

FASTENERS FOR AIRCRAFT AND MISSILES
CERTIFIED TO GOVERNMENT SPECIFICATIONS
Bolts—Nuts—Rivets—Screws—Pins—Internal and External Wrenching Bolts—Dowel and Lock Pins
Mercury air parts co., inc.
9930 West Jefferson Blvd. Culver City Cal.
TOUCH SPECIALS IN DAY DELIVERY
MANUFACTURERS OF PRECISION HARDWARE

Perfect FLORIDA Plant for Electronics, R&D, Precision Instruments

ONE STORY AIR COND. 50,000 Sq. Ft.

ULTRA MODERN BUILDING
Acreage Fronts on U.S. 17, between Jacksonville & Cape Canaveral

BINSWANGER
CORPORATION • Southern Division
Industrial Location Specialists
1420 Walnut St. Phila 2 Pa • PE 5-0202

Circle Number S-6 on Reader Service Card

A·I·R· CORPORATION
OAKLAND MUNICIPAL AIRPORT
OAKLAND, CALIFORNIA
F A A Certified Repair Station No. 4004
Sales and Guaranteed Service of Pressure Electrical and Gyro Instruments Navigation and Oxygen Equipment Class I, II, III & IV Oxygen Equipment Ltd. Send for Instrument Sales and Service Price List
OAKLAND INTERNATIONAL AIRPORT
OAKLAND CALIF
Phone LOckhaven 9-6484

Circle Number S-7 on Reader Service Card

EMPLOYMENT OPPORTUNITIES

ENGINEERS, EE.

Looking for more responsibility immediately... and a starting salary that reflects it?

General Electric's Light Military Electronics Department is seeking highly competent engineers to fill immediate technical leadership and consulting openings in the following program areas:

- Space Vehicle Guidance Systems
- Missile & Satellite Computers
- Microelectronics
- Space Detection & Surveillance
- Navigation & Communication Systems
- Silicon Crystal Circuit Development
- Command Guidance & Instrumentation
- A.E.W. & Control
- Electronic Countermeasures
- Space Communications & Telemetry
- Undersea Warfare Systems
- Thin Films
- Automated Test Equipment

THESE ARE SAMPLES OF THE IMMEDIATE OPENINGS:

TRANSISTOR CIRCUIT DESIGN
...on computers utilized in airborne early warning system.

LEAD EE
to integrate logic and circuit design efforts on space vehicle guidance equipment

CIRCUIT DEVELOPMENT AND APPLICATION ENGINEER
should be capable of doing work in the following areas: a) Power design & synthesis of complex circuitry such as is found in airborne electronics. b) Analysis of complete systems to determine and design those portions capable of being microminiaturized. c) Advise and consult with product line electronics design engineers. d) Prepare proposals.

DATA PROCESSING CONSULTING ENGINEER
...involves computer design, including logic and logic organization, basic computer circuit design, memory storage circuits and devices, overall computer systems synthesis. Also includes direct leadership of D/A projects for advance design techniques, consultation with design engineers on product line design problems, assistance in preparation of technical proposals, participation as panel member in design reviews, leadership of technical symposia in your design field

SYSTEMS ANALYST
...includes missile flight test and analysis regarding guidance systems and computation, orbital trajectory analyses, overall system sub-system and error analysis

COMMUNICATION ENGINEER
...for design studies and analyses regarding command control systems for space applications

SPACE NAVIGATION OR GUIDANCE ENGINEER
...to conduct systems studies regarding integrating hardware, e.g., developing stellar, radio or inertial navigation or guidance systems to perform specific mission function

STATISTICAL ANALYSIS ENGINEER
...to perform analyses of statistical nature e.g., correlation, error and probability of success analysis.

For a careful review of your qualifications, and a prompt reply, forward your resume today in strictest confidence. Address: Mr. R. Zukowski, Div. 64-WK, Light Military Electronics Dept., General Electric, French Road, Utica, New York.

An Equal Opportunity Employer

LMED
LIGHT MILITARY ELECTRONICS DEPARTMENT
GENERAL ELECTRIC

New, highly responsible opportunities created by vigorous growth of both military and commercial communication systems contracts—

COMMUNICATION SYSTEMS ENGINEERS

QUALIFICATIONS

—a minimum of 15 years' experience in the communications engineering field, 5 of which should have been directed toward communication systems involving microwave, telephone and teletype switching centers & data transmission

OR

—a significant level of experience in design of complete, 2-way radio systems involving mobile and station packaging, and control by local and remote means.

ALSO IMMEDIATE OPENINGS FOR THE FOLLOWING:

- Antenna Design Engineers (UHF/VHF)
- Test Equipment Design Engineers (EE)
- Subsystem Design Engineers (EE)
- Transistor Circuit Design Engineers (EE)
- Transmitter Engineers (EE)
- Receiver Engineers (EE)
- Electromechanical Engineers (EE or ME)
- Component Evaluation Engineers (EE)

▶ Facility located 4 easy driving hours from Washington, D. C., in the beautiful, Blue Ridge area of Virginia. For a prompt review of your qualifications, write today in strict confidence to Mr. W. J. Kelly, Div 64-WK.

COMMUNICATION PRODUCTS DEPARTMENT

GENERAL ELECTRIC

Mountain View Road, Lynchburg, Va.
An Equal Opportunity Employer

REPRESENTATIVES FOR PRESSURE SWITCHES

New opportunity for top notch men to represent expanding Speidel facility.

We're looking for the best men, wherever you are, to supply us with pressure-switch requirements. Previous representation of pressure switches or allied line is required.

This is a ground floor opportunity to join a new aggressive organization aiming for 1st place in the market.

Join Tomorrow's leader—today!

Speidel CORPORATION
INDUSTRIAL DIVISION
Pressure Controls Group
Warwick, R. I.

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 645 N. Michigan Ave.
SAN FRANCISCO 11: 255 California St.

POSITION VACANT

Licensed Helicopter Mechanics experienced on Sikorsky S-[illegible] or Bell Helicopters—Permanent employment. P-8106, Aviation Week.

SELLING OPPORTUNITY AVAILABLE

Manufacturers Representative Wanted. Fluid control component and systems manufacturer supplier in the missile and aerospace industry, has prime territories available especially throughout Central and Rocky Mountain States. Send complete details. Pneu Hydro Valve Corp., 52 Horne Hill Road, Cedar Knolls, New Jersey.

POSITIONS WANTED

Sales and Service Manager, Aircraft Accessories and components. Excellent Canadian contacts and good background. Desires position similar to present one. PW-8388, Aviation Week.

Public Relations with sales background in commercial airlines. Served twelve years State Legislature. Eight years Dist. Mgr. commercial airlines. Desire connection with company or association. William Lennox, 1118 N. Tejon, Colo. Spgs. Colo.

President—Age 39—Current Three Million dollar engineering marketing corporation. Desires Geographic change and new challenge. Replies handled confidentially and ethically. PW-8207, Aviation Week.

Frenchman—Top Level Executive—former Air Force General and Research Development Chief—3 yrs US—6 yrs NATO—Polytech grad.—excel. contacts in French Aviation and various industries—would like to join US co. PW-8191, Aviation Week.

IN ALL INTERESTS OF AVIATION

If You're Important, you either read

AVIATION WEEK

or you advertise in it, or both

EMPLOYMENT OPPORTUNITIES

The advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for additional Employment Opportunities advertising.

Positions Vacant	Selling Opportunities Wanted
Positions Wanted	Selling Opportunities Offered
Part Time Work	Employment Agencies
Civil Service Opportunities	Employment Services
	Labor Bureaus

RATES

DISPLAYED

The advertising rate is $60.20 per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.

An Advertising Inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED

$2.20 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Position Wanted Ads are ½ of above rate.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to
Classified Advertising Div. of AVIATION WEEK
P. O. Box 12, N. Y. 36, N. Y.

Put Yourself in the Other Fellow's Place

TO EMPLOYERS · TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

Mr. Employer, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

Mr. Employee you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

McGraw-Hill Publishing Co., Inc.
330 West 42nd St., New York 36, N. Y.

You can be sure to play an important part in the exploration of space ...when you join NASA

A factual statement on career opportunities for scientists and engineers from James E. Webb, head of NASA

The exploration of space for peaceful purposes and the benefit of all mankind is the most challenging assignment ever given to the American scientific and engineering community.

To the men of NASA, the space program has many objectives: broad-scale rapid advancement of scientific knowledge of space, the moon and planets . . . the creation of a worldwide operational network of weather satellites . . . the establishment of a global satellite system of communications . . . prompt feedback of space technology into our economy . . . and many others. Technological advances through our space effort will bring total benefits exceeding those of any other undertaking in history.

The scientists and engineers who are directly involved in NASA's space program are faced with formidable research and development problems. NASA needs—and seeks—the best creative scientific and engineering talent our nation has to offer.

We will provide the professional men who join NASA with the tools they need: a truly intellectual atmosphere, a framework for easy communication with colleagues in universities as well as government and industry laboratories, the most advanced equipment available, and the technical and clerical support to let you concentrate on the important aspects of your work.

Still the greatest personal satisfaction may be found in the scope of the individual assignment and in the end product of the work—breaking out from the world we know into an entire new world and uncovering a flood of new benefits not only for ourselves but for all mankind.

James E. Webb

To scientists and engineers in all disciplines, at all levels

The dynamic expansion of NASA has created outstanding career positions and opportunities for rapid advancement. Career appointments are available in ten different locales: Washington, D. C.; Greenbelt, Maryland; Mountain View and Edwards, California; Hampton and Wallops Island, Virginia; Cleveland, Ohio; Huntsville, Alabama; Cape Canaveral, Florida; and Houston, Texas.

Find out how you may contribute to the American space effort. You need send only one resume—it will be reproduced and distributed to all NASA facilities for evaluation.

Write to: Director, Professional Staffing N-48-1, Headquarters, Washington 25, D. C.

AN EQUAL OPPORTUNITY EMPLOYER   POSITIONS ARE FILLED IN ACCORDANCE WITH AERO-SPACE TECHNOLOGY ANNOUNCEMENT 252B

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ENGINEERS GAIN A NEW PERSPECTIVE AT AC

AC, the Electronics Division of General Motors, has made a distinct contribution to technological advancement in the field of low-altitude aircraft operation. You, too, can develop and improve your career in the areas of guidance and navigation if you are an Electrical Engineer, Mechanical Engineer, Physicist or Mathematician. Current projects include Integration and Engineering of the AN/ASQ-48 Weapon System for the B-52C&D aircraft, Inertial Guidance Systems for the Titan II, and the development of a Stellar Inertial Guidance System for advanced missiles. If you have related experience and are interested in any of the following positions please contact Mr. G. R. Raasch, Director of Scientific and Professional Employment, Dept. 5753, 7929 South Howell, Milwaukee 1, Wisconsin.

MILWAUKEE Weapon Systems Program Engineers ▪ Radar Design and Development Engineers ▪ Radar Systems Engineers ▪ Radar Test Engineers ▪ Reliability Program Engineers ▪ Field Service Engineers ▪ Electromagnetic Engineers ▪ Supplier Contact Engineers ▪ Quality Control Engineers/Analysts ▪ Technical Writers and Editors ▪ Scientific Programmers ▪ Ceramic Engineers

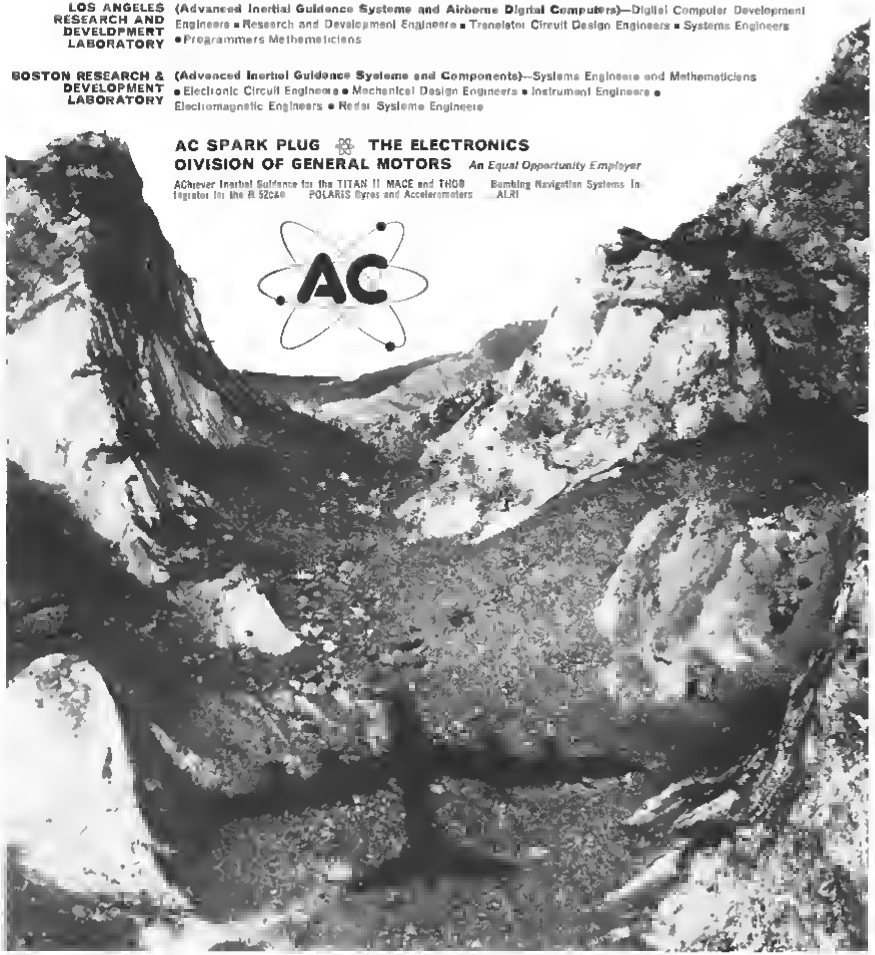
LOS ANGELES RESEARCH AND DEVELOPMENT LABORATORY **(Advanced Inertial Guidance Systems and Airborne Digital Computers)**—Digital Computer Development Engineers ▪ Research and Development Engineers ▪ Transistor Circuit Design Engineers ▪ Systems Engineers ▪ Programmers Mathematicians

BOSTON RESEARCH & DEVELOPMENT LABORATORY **(Advanced Inertial Guidance Systems and Components)**—Systems Engineers and Mathematicians ▪ Electronic Circuit Engineers ▪ Mechanical Design Engineers ▪ Instrument Engineers ▪ Electromagnetic Engineers ▪ Radar Systems Engineers

AC SPARK PLUG ⊛ THE ELECTRONICS DIVISION OF GENERAL MOTORS *An Equal Opportunity Employer*

AChiever Inertial Guidance for the TITAN II MAGE and THOR Bombing Navigation Systems for integration in the B-52C&D POLARIS Gyros and Accelerometers ALRI

AC



Editions du Pont-Royal

S T O L

The Breguet 941 has been recognized by the U.S. Federal Aviation Agency* as the only true STOL aircraft in existence. The take off run is less than 450 feet and the landing run is less than 275 feet. The payload varies between 6.500 and 15.500 lbs.

*Project Hummingbird

SOCIÉTÉ ANONYME DES ATELIERS D'AVIATION LOUIS BREGUET PARIS 16

BASIC TEST FOR MEDIA SELECTION:

In the world-wide aerospace market

Ask anyone, anyone you're trying to sell what publication he reads and respects most.

A powerful editorial force is a powerful selling force.

Aviation Week and **Space Technology**

A McGraw-Hill Publication 330 West 42nd St New York 36 N.Y.

ABC PAID CIRCULATION 82 329

Life Support Algae Studies—General Electric, MSVD

House Unit Orders Use of B-70 Funds

Armed services group votes extra $491 million for RS-70 version in attempt to save manned bombers.

Washington—House Armed Services Committee last week voted to test congressional authority over Defense Department spending by ordering the Air Force to spend an additional $491 million on the reconnaissance strike version of the North American B-70 in Fiscal 1963.

The committee's action not only sets the stage for debate on the constitutional question but virtually assures the biggest clash yet between Congress and the Defense Department over how much the U.S. should spend on long-range bombers.

Secretary of Defense Robert S. McNamara said he will ask to appear before the appropriate congressional committees to oppose expansion of the B-70 program. He said the Joint Chiefs of Staff, with the exception of Air Force Chief of Staff Gen. Curtis E. LeMay, support the present program which requests only $180 million for research and development for Fiscal 1963.

Basically, the House Armed Services Committee argues that manned bombers are being discarded prematurely in favor of missiles while the Defense Department says it is striking a realistic balance of forces. Defense units was broken recently when Gen. LeMay asked House and Senate committees to enlarge the B-70 program by building six instead of the programmed three aircraft and adding weapon systems capability to all six (AW Mar. 5, p. 23).

The House Armed Services Committee, in reporting the Defense Department aircraft and missiles authorization bill, said "the manned bomber, the one strategic weapon which has been tried and which works, appears to be destined to become the forgotten weapon in our arsenal. Our planned strategic force is approaching an inflexible state with a much reduced capability for exercising trained human judgment and control.

As our missile force grows, the role for manned strategic aircraft shifts more toward observing, reporting, evaluating and exercising on-the-spot judgment and action." The reconnaissance strike version of the B-70 (RS-70) is ideally suited" for this operation, the committee said.

Specifically, the committee said the RS-70 would perform these four tasks: "observe and report the condition of the enemy during and after the initial strikes; increase assurance of destruction of priority targets seek out and destroy unique targets—the extremely hard, the mobile and the imprecisely located, and provide the precision, discrimination and flexibility which must be an inherent part of our strategic capability. The RS-70 would fill a serious void by adding vision, strength, flexibility and human judgment which is so essential to our strategic posture," the committee said.

The committee seeks to obtain more direct authority over the RS-70 program through two amendments it added to President Kennedy's Fiscal 1963 authorization bill. One directs the Air Force to use $491 million in Fiscal 1963 "to proceed with production planning and long lead time procurement for an RS-70 weapon system." The other would prevent Congress from appropriating any RS-70 research and development money without first passing an authorization bill. This amendment would extend to the House and Senate armed services committees the authority over military research funds now exercised exclusively by the House and Senate appropriations committees.

Chairman Carl Vinson (D-Ga.), referring to the Defense Department's refusal to spend the additional money Congress voted last year for long-range bombers, said "the time has come" to determine whether Congress can only deny money or whether it also can "exercise a positive authority" by requiring certain funds to be spent.

His committee's report said the RS-70 amendment means the Air Force is "directed, ordered, mandated and required" to spend the $491 million authorized. "If this language constitutes a test as to whether Congress has the power to so mandate," the report said, "let the test be made and let this important weapon system be the field of trial."

Rep. Vinson told AVIATION WEEK he has not consulted with leaders of the House appropriations committee on the amendment to give his committee jurisdiction over RS-70 research money, but he said: "I think I'll win this fight in the House." The House Armed Services Committee justified giving itself this authority over research funds by declaring in its report that the RS-70 weapon system "should receive as broad a congressional scrutiny as is possible in order to ensure that this weapon system proceeds at a pace consistent with advances in technology and military requirements."

So far, the Defense Department emphasis in the RS-70 controversy has been on the technical reasons for not assigning the aircraft a larger role in the strategic forces.

A Defense spokesman said development of a side-looking radar that could operate at speeds of Mach 3 and components for the remainder of the weapon system, will take much longer than construction of the airframes. It would be illogical, he said, to have a number of aircraft built with nothing to put into them, and for that reason the current program is limited to three aircraft.

The reconnaissance system would require development of in-flight data display and processing, training of personnel in processing and interpretation and transmission to the command net work. All these components have yet to be developed and proved, he said.

The third aircraft of the three-plane program, which was originally designed to carry a bomb-navigation system, now is subject to a year's engineering freeze that will permit installation of reconnaissance strike components so it can be used as a testbed.

The RS-70 system also involves development of air-to-surface ballistic missiles that could be launched at supersonic speeds.

President Kennedy last week strongly supported the Defense Department's proposed delay in committing the B-70 to production before prototype aircraft are tested in 1963 or 1964. He told his press conference he hoped this approach could be worked out with the appropriate congressional committees.

In opposition to Defense Department's argument the House Armed Services Committee said it is "gravely concerned that we are abandoning to the enemy the development and production of the flexible weapon system which has successfully kept the peace for many years."

The committee said "there is clear need for a manned strategic reconnaissance-strike aircraft. Incorporation of recent state-of-the-art advances in missiles, communications and reconnaissance sensors in the B-70 can provide an advanced reconnaissance strike operation which is ideally suited for operation in the missile era."

House Sentiment

Majority House sentiment on the RS-70 issue will be demonstrated when the authorization comes to a vote—probably this week. Then the appropriations committee will vote on the issue in reporting its Defense Department Fiscal 1963 appropriations bill. Senate voting will follow that in the House.

All told, the House Armed Services Committee recommended adding $587.5 million for aircraft and missiles and cutting $2.8 million from the Navy's shipbuilding program. These were the additions other than the $491 million for the RS-70:

- **Army aircraft:** $55.3 million for more of these aircraft: de Havilland AC-1 Caribou, Bell HU-1B Iroquois and H-13 Sioux helicopters, Hiller H-23 Raven helicopter, Grumman AO-1 Mohawk combat surveillance aircraft, Beech L-23F Seminole utility transport.
- **Army missiles:** $31.2 million for additional Army missiles of various types.
- **$10 million** to provide the Air Force with additional Boeing Minuteman missiles so that "the ultimate number procured and placed in position will more truly represent the capability which this country must have in the years ahead."

The committee report also endorsed resumption of nuclear testing in the atmosphere, declaring that "actual weapons systems" should be used.

OSO-1 in Orbit

Washington—Orbiting Solar Observatory 1 (OSO-1) satellite, designed to obtain measurements for a statistical analysis for predicting solar flares, was launched at 11:06 a.m. Mar. 7 from the Atlantic Missile Range as the seventh successive successful Douglas Thor-Delta launched payload.

The 450-lb. satellite (AW Feb. 26, p. 55) had a 96-min. period and was orbiting with an apogee of 370 mi. and perigee of 340 mi. During its first orbit, 12 of the 13 scientific instruments on board were transmitting data. The satellite, which has an anticipated active lifetime of six months, stores data 90 min. and transmits during the other six minutes of each period.

Bell Helicopter Order

Washington—Bell Helicopter Co.'s Model 204 (Army HU-1B) has been chosen by the Navy as an interim assault support helicopter (ASH) for Marine Corps use.

To meet critical shortages of this type of aircraft until a new one is developed, it was decided to buy the existing Bell model. The program is expected to involve about 105 aircraft over a three-year period.

Only minor modifications will be made, such as Marine Corps-specified avionics and a greater visibility windshield. No contract figures have been announced. Army HU-1B costs about $250,000 while the commercial 204 costs from $325,000 to $350,000, including engine and electronics.

Communication Carrier Ownership Of Comsat Firm Urged in Senate

By Katherine Johnsen

Washington—Congressional support for early establishment of a corporation owned by communications common carriers to develop and operate a worldwide communications satellite system continued to grow last week as the Senate space committee went into its second week of hearings.

The major contributing factor was testimony by the Federal Communications Commission that our privately owned common carriers, under governmental regulation, have provided the nation with an unparalleled communications system, and may confidently be relied upon to fulfill the objectives of our nation's satellite communication program."

American Telephone & Telegraph Co. almost certainly would be dominant in the common carrier corporation. AT&T has already volunteered to invest $65 million at the outset. Investments volunteered by other common carriers so far total $13 million.

FCC Chairman Newton N. Minow called for specific safeguards to prevent monopolistic abuses from emerging in the new satellite corporation. These included a requirement for competitive bidding in the procurement of equipment and services, authorization for FCC to determine the appropriate technical characteristics of the satellite facilities, and equal representation on the board of directors by each carrier regardless of the amount of its investment.

Sen. Robert S. Kerr (D-Okla.), chairman of the Senate space committee told AVIATION WEEK that he expected his committee to approve legislation authorizing a common carrier corporation in the very near future and in such a form that it would win Administration approval. The measure will then be referred to the Senate commerce committee for further consideration. The House commerce committee is scheduled to start hearings on the subject Mar. 13.

The President's proposal for a corporation financed by public sale of stock (AW Feb. 12, p. 26) still failed to gain strong vocal support from either House or Senate members. A determined but minority group in Congress, led by Sen. Estes Kefauver (D-Tenn.), is fighting for government ownership.

Nicholas Katzenbach, assistant attorney general, and Dr. Edward Welsh, executive secretary of the National Aeronautics and Space Council—the two government spokesmen for the President's public ownership plan—stressed the equity in opening investment opportunity to all taxpayers in a government-fostered monopoly. Kerr and Sen. Stuart Symington (D-Mo.), countered that this objective could be indirectly achieved through public investment in the common carriers owning the satellite system. Katzenbach and Welsh acknowledged that few companies have as broad based ownership as AT&T.

Democratic as well as Republican senators on the space committee were apprehensive that under a public financing plan, one of two undesirable situations might develop:

- **If the satellite corporation** were presented as an initially uneconomic operation which would not pay dividends until about 1970—and there appears to be general industry agreement on this—sufficient stock would not be purchased, creating delay in the U.S. program for leadership in the satellite communications field.
- **If the stock were glamorized** as a new space age opportunity, it might be purchased too eagerly, with a result that many small-scale investors might be disappointed if they failed to make a profit. Symington recalled that because of its glamor appeal, Radio Corp. of America stock skyrocketed to $500 a share in the late 1920s, without any dividend payments, and then plunged to $3 a share after the 1929 crash.

James E. Dingman, executive vice president of AT&T, stressed that his company is not committed to any specific type of satellite system. AT&T's proposal for a random-orbit system, he said, was based on the belief that this could be achieved first.

Dr. Allen E. Puckett, a vice president of Hughes Aircraft Co., told the committee that a commercial system utilizing the Syncom satellite being developed by Hughes for National Aeronautics and Space Administration could be achieved "much sooner" than a low-orbit random system and at less than half the cost.

Bullpup Increase

Washington—Limited-war capability of Navy and Air Force aircraft will be increased by adding Martin Bullpup air-to-surface missiles to four aircraft and increasing the number of Bullpups carried by two others. New aircraft are Navy's Chance Vought F8U-2NL, McDonnell F4H, Grumman A2F-1 and the North American A3J. The USAF Republic F-105 will carry four instead of two Bullpups and the Navy-Douglas A4D-5 will carry five instead of three.

AT&T Team Will Assist NASA In Space Flight Systems Analysis

Washington—American Telephone and Telegraph Co will provide a 400 man management force to strengthen National Aeronautics and Space Administration capability for systems analysis of manned space flight projects, but NASA emphasized to Congress that it will retain full decision responsibility for its programs.

The agency agreed with Rep Emilio Q Daddario (D-Conn) that AT&T is part of its "management crutch" made necessary because top-level people cannot be recruited fast enough for demands. Additional support comes from General Electric Co which was awarded a contract last month for integration and checkout of Apollo systems (AW Feb 19, p 26). NASA Administrator James E Webb forecast the award of the AT&T contract as the agency began its fiscal 1963 appropriation hearings (AW Mar 5, p 24).

Rep Daddario closely questioned Dr Robert C Seamans Jr, associate administrator, and Brainerd Holmes, director of Manned Space Flight on NASA's future management concept at a subcommittee hearing last week. In response to his questions, Dr Seamans responded:

• Holmes is the "man we will call if there is any difficulty in the manned space flight program. Wernher von Braun, director of Marshall Space Flight Center, will report to Holmes on all matters pertaining to this program, which constitutes about 90% of Marshall's work. In a major organizational change, Dr Kurt Debus, director of NASA launch operations at the Atlantic Missile Range, will report to Holmes rather than von Braun.

Dr Debus' organization has been elevated to center status. It will become the NASA Launch Operations Center responsible for all NASA activities at AMR. Pacific Missile Range will report to Dr Homer E Newell, director of space sciences. Its name will be NASA Pacific Launch Operations Office, directed by Navy Cdr Simon J Buttschell. The PMR activity previously reported through Debus to von Braun.

• Functional USAF Systems Command relationship with NASA has been "amicably" worked out with a new office now being organized. This office, first reported by AVIATION WEEK (Jan 1, p 15), is expected to be formally activated soon. It will consist of 30 Systems Command officers in NASA who will report to Gen B A Schriever, AFSC commander, on day to day technical matters.

The Systems Command office, however, will not make decisions on centers or facilities. Dr Seamans said. He said each NASA construction item in the Fiscal 1963 budget was coordinated through the Defense Department, "and all questions of duplication were resolved before they were included in the budget."

The AT&T contract will involve 200 professional engineers, scientists and mathematicians and 200 supporting employes. Most will be assigned to Washington and will conduct specific technical studies and analyses for Joseph F Shea, Holmes' deputy director for systems.

Snap 11 Development

Washington—Martin Marietta Corp has been selected by the Atomic Energy Commission to design, construct and ground test a Snap 11 nuclear-powered electrical generator for the National Aeronautics and Space Administration's Surveyor lunar landing spacecraft.

The generator will power spacecraft instrumentation continuously for 90 days, with outputs ranging from 18 6-25 watts. It will be drum-shaped 20 in high and 20 in dia. Total weight including shielding will be 30 lb (AW Nov 13, p 85).

Snap 11 will be fueled by curium 242 which will be alloyed because of its high temperature. As this element decays spontaneously, it produces heat which is converted directly into electricity.

GE Fuel Cell Picked For Gemini Capsule

Washington—Electrical power for the two man Gemini spacecraft will be provided by a hydrogen-oxygen fuel cell developed by General Electric, marking the first application of this type of energy conversion unit to an operational space system.

The fuel cell developed by GE's Direct Energy Conversion Operation, West Lynn, Mass, was selected last week by McDonnell Aircraft Corp, builder of the Gemini capsule for the National Aeronautics and Space Administration, and the contract is now being negotiated.

Average power requirements of the Gemini cell—with the exception of duration—are very similar to those expected of the cell to be used for the three-man Apollo capsules' earth orbit and circumlunar missions. It differs from the fuel cell to be used in Apollo's lunar landing mission both in lifetime and the heat rejection subsystem.

The GE Gemini cell is a low temperature, low pressure ion-exchange membrane type. The solid electrolyte is a GE-developed material identified only as Polymer A-prime, a plastic material with good ion conducting properties.

GE will provide only the cell to McDonnell, which will furnish the fuel supply and feed systems and the heat rejector, or radiator. The cell subsystem will be composed of three modules, two of which will be used for normal operations and the third held in reserve. Should one of the two operating modules fail, the reserve cell would be hooked up with the remaining good module for continued operation. Any module could deliver sufficient minimal emergency power by itself.

NASA and McDonnell specifications for the Gemini power system called for a 28 v, 2-kw unit with a reliability of approximately 0.998. GE's unit is said to weigh under 300 lb.

Apollo Fuel Cell

Washington—Pratt & Whitney and the team of Tapco-Ionics were expected to be awarded a dual development contract late last week for the Apollo spacecraft fuel cell. P&W is developing a Bacon type cell fueled by hydrogen and Tapco-Ionics is developing a hydrogen-oxygen type cell.

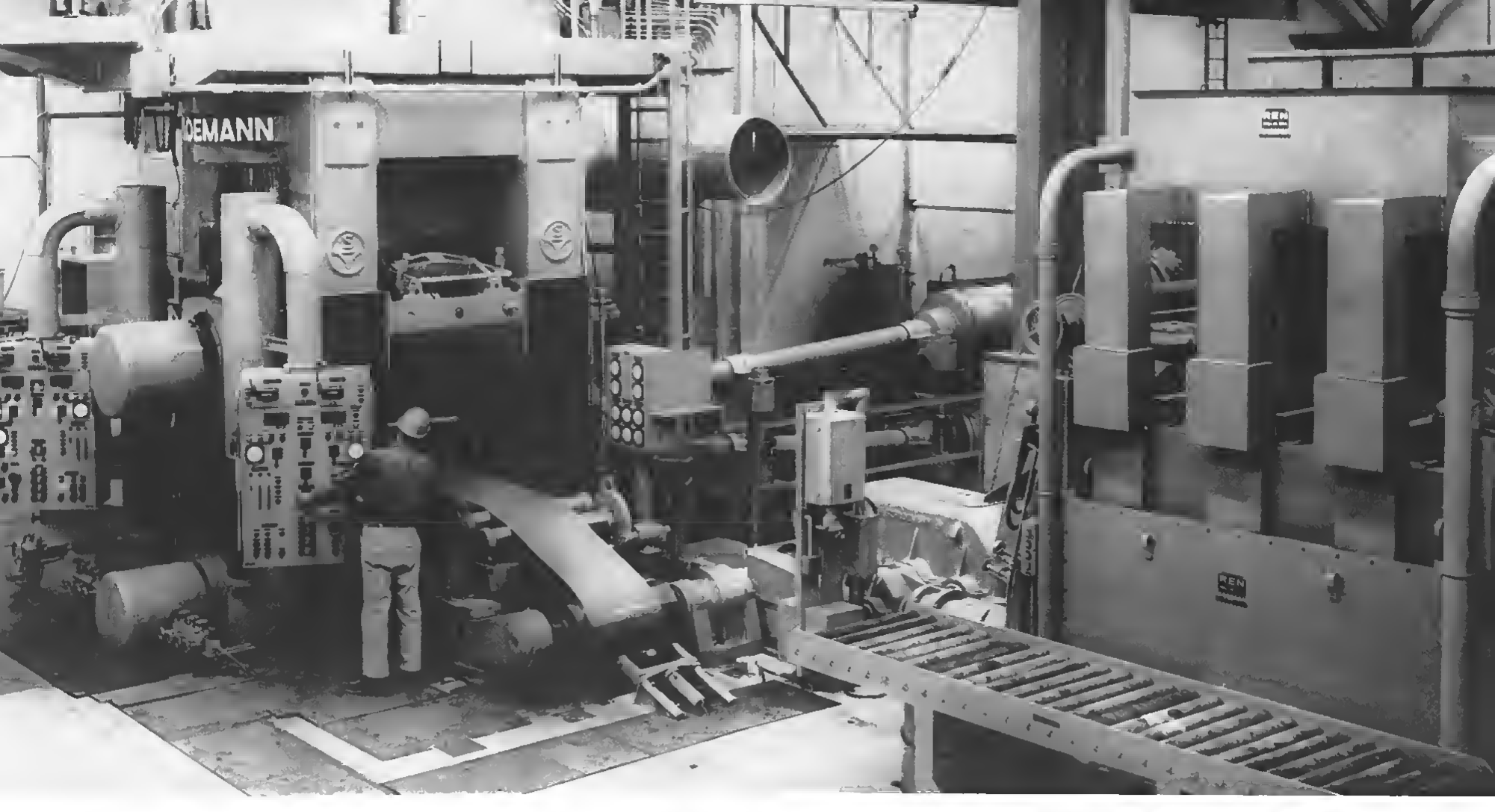
B-58A Cross-Country Dashes Set Records

Ft Worth, Tex—Supersonic Convair B-58A Hustler bomber of Strategic Air Command's 43rd Bomb Wing, Carswell AFB, set three speed marks west-to-east and east-to-west across the U S.

Record marks attained Mar 5 were Ontario, Calif-New York International Airport—2 hr 1 min 39 sec, averaging 1,212.6 mph turnaround over the Atlantic Ocean near New York and a dash from the International Airport "gate" to California "gate" nonstop in 2 hr 15 min 12 sec at an average speed of 1,091.2 mph. The third record comprised the overall time of 4 hr 42 min 32 sec and an average speed of 1,044.3 mph, including turnaround.

Two B-58As took off from Carswell AFB. The second B-58A completed the west-east leg but developed a fuel system malfunction and landed at Whiteman AFB, Sedalia, Mo.

The record-breaking Hustler refueled over the Pacific after arrival from Carswell to top off its tanks prior to entering the Ontario gate. Another aerial refueling was made near Kansas City, Mo, one over the Atlantic and a third mid-way over the U S on the return.



The Du Pont Metals Center

the first facility of its kind for producing columbium and other refractory metals

THE DU PONT METALS CENTER is the only plant of its kind in America, built especially to produce columbium and other refractory metals.

Take the rolling mill you see here. There's none other like it in the country. It can produce refractory metals in thicknesses from 2" to .002" and up to 30" wide. It is just a part of this remarkable Du Pont plant, custom designed every step of the way to provide you with quality mill products in the refractory metals.

The Metals Center produces ingots, billets, bars, sheet, strip, plate, tube hollows and solid extrusions in the refractory metals. It's currently producing Du Pont-developed D-14, D-31, D-36 and other columbium alloys. It can also handle conversions for *other* makers of refractory alloys and superalloys.

If you are a prime contractor to military and government agencies, or involved in projects requiring applications for refractory metals, you are invited to discuss your needs with one of Du Pont's experienced metallurgical engineers. For a Data Sheet on Du Pont Metal Products, write to Du Pont, D-2058, Wilmington 98, Delaware.

THE DU PONT METALS CENTER DU PONT

Better Things for Better Living *—through Chemistry*

Circle Number 315 on Reader Service Card

Powers' Capitol Testimony Adds Little to Knowledge of U-2 Affair

By George C. Wilson

Washington—Theory that a Russian ground-to-air rocket downed the Lockheed U-2 aircraft piloted by Francis Gary Powers gained support last week after Powers told the Senate Armed Services Committee about his mission in his first public appearance since he was released from the Soviet Union.

Although Powers emphasized that he was not sure exactly what happened to his aircraft as he approached Sverdlovsk, Russia, on May 1, 1960, Chairman Carl Vinson (D-Ga.) of the House Armed Services Committee said the Central Intelligence Agency believes Russia's claim that it shot down the U-2 at 68,000 ft. with a ground-to-air rocket.

Theory Confirmed

A high-ranking member of the Senate committee told AVIATION WEEK that all the CIA testimony he had heard about the Powers flight tended to confirm the rocket theory. The CIA itself has made no public comment about the type of weapon Russia may have used.

Senators at the hearings refrained from pressing Powers, still employed by CIA, on such questions as the altitude at which he was flying and the kind of weapon he thought downed his U-2. "I just know that there was an explosion," Powers said. "I feel sure that it was external to the aircraft. But how it got there or what it was, I have no idea."

Powers also said that his Russian captors "stressed many, many times that they got me on the very first shot of a rocket, but they stressed it so much that I tend to disbelieve it."

These are the highlights of Powers' testimony before the Senate committee:

"I can remember feeling, hearing and just sensing an explosion, but there was no—just a slight acceleration of the aircraft was all that I felt in the aircraft itself. I immediately looked up from the instruments and everywhere I looked was orange. I don't know whether the whole sky was orange or just the reflection of an orange light in the canopy, but I had never seen anything like this before, and I am sure there was an explosion. I feel the explosion was external to the aircraft and behind me, but I really don't know.

"The right wing started to drop, which is normal in an aircraft—it wanders around a little—and I turned the wheel, brought the right wing back to level position, and either after it reached the level position or just before it reached that, the nose started dropping.

"So I applied back pressure to the control column and felt no resistance to the movement of the control column, and this kept going faster and faster. So I immediately assumed at the time that the tail section of the aircraft had come off. . . I think I reached a position about like this [Powers held up a model of the U-2 in a steep nose-down attitude], and I feel sure that both wings came off. This was where the very violent maneuver took place. It ended up in a spin about this position [he held the model upside down with the nose tilted sharply upward].

"The g forces were very strong. I have no way of estimating how much. I know that when I tried to get in the ejection position, it took both hands on my legs to pull my feet back into the stirrups of the ejection seat.

"It was spinning very violently. I was thrown forward and up, and I was hanging on to the seat belt not sitting in the seat. I immediately—my first reaction was to reach for the destruct switches, and I reached up. I don't know whether I touched them or not. But I thought that I had better see if I can get out of here before using this. I knew that there was a 70-second time delay between the time of the actuation of the switches and the time that the explosion would occur. . . I tried to get into position in the ejection seat so that I could use it."

Powers said he recalled a friend telling him of a similar situation in which the friend told himself he must stop and think. . . And along in here I saw 34,000 ft. on the altimeter, and it was still moving very fast.

Powers said he opened the canopy but could not get out of the aircraft because he had forgotten to unfasten his oxygen hoses.

So when I decided just to try to get out, I gave several lunges and something snapped and I was floating free."

Immediate Capture

Powers said he was captured right after landing in a farm field. He said one of the Russians in the crowd which surrounded him pointed up in the air, "and I looked up and saw what I think was a parachute, but I knew I had no other parachute on board the aircraft. . . It was very high. I don't know how high. . . I thought at the time that maybe this explosion was caused by a rocket, and, if so, maybe this parachute was used to recover, say, the first stage or something." He said the parachute was similar to his but of a different color. He said it had red and white markings.

U.S. Contests Titov Flight Record Claim

Washington—U.S. is contesting the space flight duration record claim made by Soviet Maj. Gherman Titov on the basis that he did not land in his spacecraft following his orbital flight, but ejected himself and landed by parachute.

Federation Aeronautique Internationale will consider this protest May 12 along with U.S. and USSR space record claims during the second day of the FAI Astronautics Subcommittee meeting in Paris. One rule for manned flight space record claims is that the pilot be launched and landed in his space vehicle. Because Soviet documentation indicates Titov parachuted, the National Aeronautic Assn. is claiming the flight duration record for U.S. Lt. Col. John H. Glenn, Jr., on the basis of the Mercury Atlas-6 flight Feb. 20 (AW May 5, p. 18).

There are five record categories under the new manned space flight listing:

- Greatest mass lifted in earth orbit. This is being claimed for the flight of Maj. Yuri Gagarin, whose Vostok 1 craft weighed 10,460 lb. Vostok 2 weighed 10,434 lb., and orbital weight of the Mercury capsule is 2,987 lb.
- Greatest mass lifted without earth orbit. This is being claimed for flight of Cdr. Alan B. Shepard, Jr., in Freedom 7, which weighed about 2,900 lb. in its space configuration.
- Greatest altitude in earth orbit. This record is claimed for Gagarin, who reached 185 mi. Apogee for Col. Glenn's Friendship 7 was 162 mi., and for the Titov vehicle, 160 mi.
- Greatest altitude without earth orbit. This is claimed for Capt. Virgil I. Grissom in Liberty Bell 7, 118 mi. Cdr. Shepard's apogee was 116.5 mi.
- Flight duration. This is the contested claim of Titov in Vostok 2, which was 25 hr. 18 min. If the FAI does not uphold this claim, the record will go to Col. Glenn whose flight lasted 4 hr. 56 min. Gagarin's flight duration was 89.1 min.

Future claims for space flight records in all categories must exceed these first records by at least 10%. Aircraft record claims must exceed existing records by 1% in speed and 3% in altitude.

Riddle Asks Hawker-Siddeley For Financial, Mechanical Aid

Washington—Riddle Airlines has urged the British Hawker Siddeley combine to underwrite an extensive mechanical improvement program for Riddle's AW 650 freighter fleet and to guarantee loans for the airline.

Lending urgency to Riddle's request was a telegram from Military Air Transport Service asking the airline to detail steps being taken to boost low utilization of the four turboprop Argosy along Logair routes operated by the carrier.

According to MATS, Riddle has failed to provide satisfactory Logair service with the Argosy. Riddle says malfunctioning of many Argosy systems and components has been the prime reason for the aircraft's poor record.

Riddle said Hawker Siddeley's reply to this complaint was that Riddle's failure to acquire an adequate inventory of spares for the seven Argosies was responsible.

MATS gave Riddle a Mar. 7 deadline to report a program for lowering Argosy out of commission time. Riddle responded with a request for additional time and sought to postpone any further reply until its president, Robert M. Hewitt, had returned from London last week. Hewitt's meeting with Sir Roy Dobson, Hawker Siddeley's chairman, probably would decide the future of the Argosy in the U.S., Riddle told MATS.

With Riddle still in debt to Hawker-Siddeley for the Argosy fleet, and several weeks behind in making interest and principal payments on this and other equipment, Hewitt was expected to urge that Dobson endorse a program under which Hawker-Siddeley would:

- **Guarantee existing loans** negotiated by Riddle for equipment and certain services, thus making new lines of credit available to the carrier.
- **Help Riddle establish** an adequate inventory of spare parts and engines by arranging new guaranteed loans that would go directly to the carrier.
- **Assign a team** of specialists to Riddle's Miami overhaul base to organize a maintenance program.
- **Pay half the cost** of replacing certain Argosy components that have high in-flight failure rates, according to Riddle.

It is doubtful whether Hawker-Siddeley will accept these terms or even a compromise that retains much of their substance. But there is also little probability that the British manufacturer will foreclose on Riddle's debt, for to do so in the wake of the old Capital Airlines-Vickers Viscount financing problem might seriously reduce Great Britain's chances of exporting aircraft products to the U.S. in the future.

Rather than force Riddle to curtail operations, representatives of Hawker Siddeley, various vendors of the airline and General Aircraft Leasing Co. (GALCO) met in New York last month and agreed to a moratorium on the airline's debt payments. Nevertheless, many potential vendors have put Riddle on a cash-only sales basis. GALCO sold Riddle 10 former American Airlines DC-7s.

Informed sources told AVIATION WEEK that Riddle bought $760,000 worth of spare parts to support the first five AW 650s it purchased. When the airline increased its order to seven, no further spares were purchased. In December, 1960, the manufacturer warned Riddle that its Argosy operation would face serious problems in three months unless additional spares were ordered, these sources said.

Of Riddle's seven Argosies, five were flying Logair routes last week. The remaining two were undergoing overhaul, but one of these also was being cannibalized by the carrier to support the other six.

Hawker-Siddeley has made overtures aimed at measuring the interest of another all-cargo carrier, Slick Airways, in acquiring the Riddle AW 650s. Initial reaction within the company is that the Argosy may have some potential as a short-haul freighter, but that the current financial posture of Slick could not support purchase of seven aircraft.

Slick and Riddle officers have explored the ramifications of merger in what they describe as "casual talks" over the past nine months. Slick admits that the combination would make sense, but prefers not to begin hard negotiation until Riddle makes available detailed and audited data on its debts, cash generation capability and overall resources. Riddle, according to Slick, has not furnished such information.

Riddle stresses that it is not on the verge of an insurmountable financial crisis. Although the shortage of operating capital has grown critical in recent months, Riddle can count on a steady flow of cash from MATS overseas airlift contracts, a company official said last week.

New Controversy, Many Suits Due After Airport Noise Ruling

Washington—U.S. Supreme Court decision that property owners must be compensated for damages caused by the noise of low-flying aircraft is expected to lead to a flood of legal actions by homeowners against airport operating authorities throughout the country.

The decision, handed down last week, has also fanned industry controversy over the unsettled issue of federal versus municipal responsibility for aircraft noise abatement.

In a 7-2 decision, the majority held that Allegheny County, Pa., as operator of the Greater Pittsburgh Airport, should pay $12,690 in damages to a homeowner forced to move because of loss of sleep and damage to his home located only 0.6 mi. from the end of a runway. The majority opinion, written by Justice William O. Douglas, noted that the official approach pattern permitted aircraft to fly as low as 11 ft. over the house and that they customarily flew between 30 and 300 ft. above the property. As operator of the airport, the opinion held, the county failed to acquire sufficient private property in the approach area to avert the problem of noise complaints from homeowners.

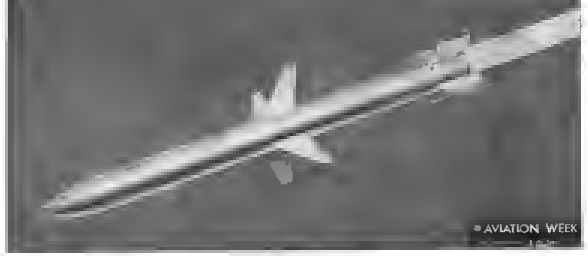
While the two dissenters concurred with the majority in the general findings, they held that the federal government, which provided much of the airport construction funds and supervises landings and takeoffs, should be liable.

The first effects of the decision may be felt in the New York City area where a group of 809 homeowners filed suit in the State Supreme Court against the Port of New York Authority last December (AW Jan. 8, p. 41).

Meanwhile, the Airport Operators Council expects to take the entire noise abatement issue before Congress. Both the Senate and House aviation subcommittees have followed the problem in the past, but neither have taken a stand on the significance of the Supreme Court action.

AOC hopes Congress will clarify the Federal Aviation Agency's authority in the noise abatement field in terms that would permit FAA to spell out aircraft design criteria necessary to reduce the noise levels. The group, pointing out that FAA is responsible for approving the operational designs of airports, contends that the federal government, rather than municipal, should be held liable for damage claims arising from airport noise suits.

FAA is studying the decision with an emphasis on the impact it might have on the agency's noise abatement operational procedures.



Navy's Shrike Anti-Radar Missile Depicted

Aviation Week artist's concept shows configuration of Navy Shrike air-to-surface missile. Texas Instruments is prime contractor for this weapon, designed to have homing capabilities against radar and other electromagnetic emission installations (AW Oct. 30, p. 25).

Napier Discontinues Civil Eland Engine

Washington—D. Napier & Son last week agreed to buy back five Convair 540 transports from Allegheny Airlines as a result of a decision by the British manufacturer to discontinue production of the civil Eland turboprop engine.

Under the agreement, Napier will purchase the five aircraft, spare parts, tools and other related items. In addition, Allegheny will be reimbursed for its pre-operating costs and other expenses associated with the 540 program which Allegheny launched two years ago.

Allegheny estimates that it has invested more than $5 million in the fleet of Convair 540 aircraft, which is essentially a Convair 440 converted to Eland turboprop power.

Lack of sales, stemming primarily from development of competitive small turbojet and turboprop aircraft, forced Napier to abandon its 540 program. Napier will limit its future aircraft engine activity to military areas. Meanwhile, it will accept delivery of the first of the Allegheny 540s on Mar. 1, the second by Apr. 20 and the remaining three prior to July 1.

News Digest

North American Aviation's Rocketdyne division has been selected by McDonnell Aircraft Corp. to develop the reaction jet attitude control system for the NASA Gemini spacecraft. In addition to normal system requirements, the development will incorporate propulsion provisions to perform rendezvous and docking maneuvers.

Requests for proposals for Mobile Mid-Range Ballistic missile probably will be issued this week by Air Force Systems Command's Ballistic Systems Division. Latest in a series of program hurdles—deliberation on whether to proceed with program as a development project or to conduct a preliminary study phase (AW Mar. 5, p. 25)—has been resolved at Department of Defense level in favor of immediate development.

Triad 3 guidance system proposal requests were distributed to industry last week by Air Force's Ballistic Systems Division. The system is to be pure inertial, rather than radio-inertial as had been considered earlier (AW Feb. 19, p. 23).

Soviet Premier Nikita Khrushchev said last week that President Kennedy's decision to resume U.S. nuclear tests in the Pacific late in April unless a test ban agreement is reached before then will present Russia with "the need to hold such tests of new types of its nuclear weapons as might be required" to strengthen its security. President Kennedy said some of the recent Soviet tests, including one over 100 mi. high, sought information on the effects of blasts on radar and communications and apparently were related to anti-missile defenses but "did not in our judgment reflect a developed system." U.S. tests will be aimed at obtaining the same kind of data and at increasing yield per pound of warheads. The U.S. last week exploded its 20th nuclear device in the current series of underground tests in Nevada.

First Atlas-Centaur test launch, often delayed, is now scheduled for Mar. 29. A new 13-day postponement last week resulted from additional checkout ordered by the National Aeronautics and Space Administration after a number of electronic components in the Centaur stage failed to return desired readings.

United Air Lines proposed 6.5% fare increase, which would be applied to pre-Feb. 1 fare levels, has been suspended until June 7 pending a Civil Aeronautics Board investigation. The proposed fare, in effect, would be a 3.5% increase on top of the 3% authorized earlier by CAB (AW Jan. 1, p. 27). United asked for the higher fare mainly to offset an expected increase in fuel taxes (AW Feb. 19, p. 38). CAB said it suspended the increase because recent traffic trends have indicated that a fare program alone could not solve the industry's financial problems.

Civil Aeronautics Board last week ended a five-year investigation of Pan American World Airways' relationship with its affiliates on ground that a probe conducted in connection with a mail rate proceeding (AW Feb. 19, p. 49) failed to disclose any law violations.

Channel Air Bridge, a British United Airways division formed to fly automobiles and passengers between United Kingdom and Europe (AW Sept. 4, p. 46), has French government permission to serve Strasbourg beginning June 1. Approval came despite strong opposition from French railroad and tourist interests, who would prefer tourists to drive through France. The airline will start service to Basle and Geneva, Switzerland, Apr. 2. All service will be from Southend, England, with ATL-98 Carvair aircraft converted from DC-4s.

Twin Coach Co. will build wing leading edges for the first five Lockheed C-141 turbofan cargo transports under $900,000 subcontract from Lockheed Georgia.

Wallops Island, Va., launch facility was extensively damaged by heavy seas Mar. 7, and probably will be out of operation for some time. Gale-force northeast winds caused flooding up to four feet in most buildings. Flooding and high tides prevented a damage assessment late last week.

USAF Boeing Minuteman made its sixth straight successful launching from a silo at Cape Canaveral, Fla., last week, flying more than 3,000 mi.

F4H-1 Record Claims

Time-to-climb records to five separate altitudes have been claimed for the McDonnell F4H-1 Phantom 2 two-jet fighter. The record runs began Feb. 21, three days after new records for four of the altitudes had been claimed for the Northrop T-38 (AW Feb. 26, p. 37).

The flights were conducted Feb. 21-Mar. 3 at the Navat Air Station, Brunswick, Me. The records claimed are:

- **3,000 meters (9,842.5 ft.) 34.523 sec.**
- **6,000 meters (19,685.0 ft.) 48.787 sec.**
- **9,000 meters (29,527.5 ft.) 61.629 sec.**
- **12,000 meters (39,370.0 ft.) 77.156 sec.**
- **15,000 meters (49,212.5 ft.), 114.548 sec.**

ADVERTISERS IN THIS ISSUE

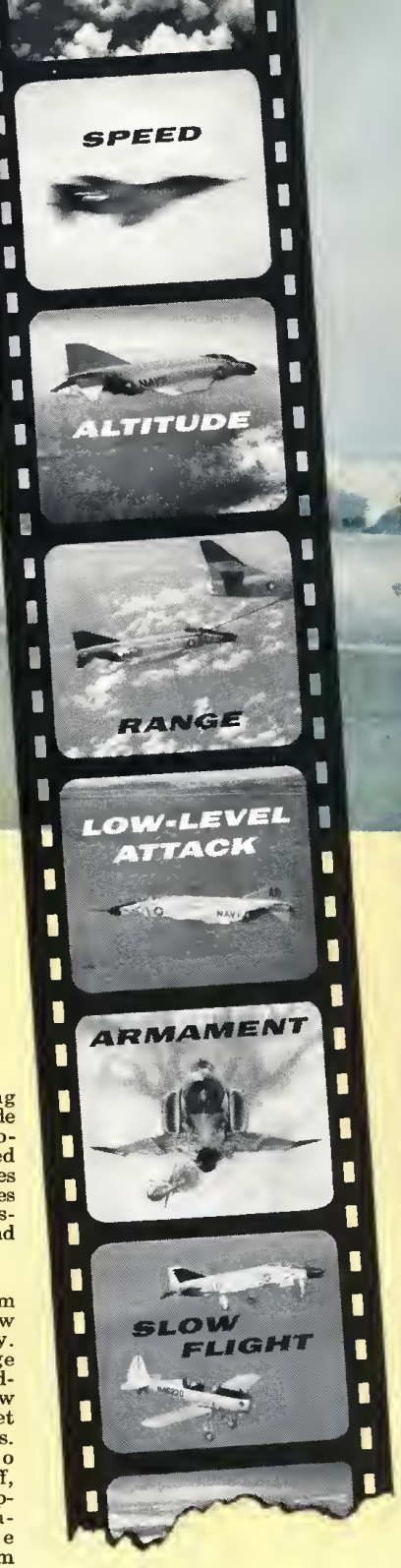
AVIATION WEEK, MARCH 12, 1962

SALES

ADVERTISING SALES MANAGER	E P Blanchard Jr
ATLANTA	R H Powell
BOSTON	A C Boughton
CHICAGO and ST LOUIS	J S Costello D C Jackman
CLEVELAND	T H Hunter Jr
DALLAS	John Grant
DENVER	John W Patten
DETROIT	M Holbard
HOUSTON	J Page
LOS ANGELES	C F McReynolds D T Brennan E A Ransdall
NEW YORK	M J Storz R Wallace J D Warth
PHILADELPHIA	J D Willis D Ferris
PITTSBURGH	J R Pierce
SAN FRANCISCO	R R Butera
PROMOTION MGR	E C Gerrie
EUROPEAN MARKETING DIRECTOR	Fulvio Piovano
RESEARCH & MARKETING	Rosalie Christesen Patricia W Abrams
MERCHANDISING	J R Gerardi

BUSINESS

BUSINESS MANAGER	J G. Johnson
CIRCULATION MANAGER	T J Lucey
ASST BUSINESS MANAGER	W V Cockren
PRODUCTION MANAGER	F A Duba



THE FEATS OF A PHANTOM

The feats of a Phantom measure its awesome combat capabilities. They are a testament to its structural strength, sheer power and armament versatility.

● Setting 100 and 500-kilometer world speed records dramatized the Phantom II's maneuverability at lightning speeds and ability to attack and re-attack evasive targets. Its intercept capability was exhibited in setting the world's absolute speed record of 1606.3 (Mach 2.5+). During this record flight the Phantom II reached peak speeds in excess of 1650 mph.

● The Phantom II holds the world's altitude record for sustained flight, maintaining 66,443 feet at Mach 2.2. With a complement of Sparrow III missiles aboard, the McDonnell-built jet zoom-climbed to 98,557 feet in a further demonstration of maneuverability and ability to launch attacks at extreme altitudes.

● To capture the Bendix Trophy, a Phantom II flew coast to coast in 170 minutes and set a new transcontinental speed record to demonstrate its deployment capability over great distances at high speeds.

● Low-level ground attack capability was emphasized by the Phantom II as it flew Mach 1.2, at times less than 125 feet above the ground, to shatter the 3-kilometer world speed record.

● The Phantom II Air Defense fighter has delivered conventional bombloads weighing twice that carried by World War II Flying Fortresses. Yet even while carrying multi-ton bombloads, the carrier-qualified Phantom II literally "flies its own cover" since it carries Sparrow III air-to-air missiles in addition to its ground attack payload.

● Final proof of the Phantom II's versatility lies in its slow flight and landing ability. Leading and trailing edge flaps, augmented by boundary layer control, allow slower than commercial jet transport approach speeds. The power of the two GE-J79 engines for take-off, matched by very slow approach speeds and para-braking, permits the Phantom II to operate from 5,000-foot runways.

In air defense, air superiority, long range attack or tactical ground support there is no match for the Phantom II.

MCDONNELL

Phantom II Fighter and Attack Aircraft •
Mercury, Asset and Aeroballistic Spacecraft • Talos and Typhon Missile Airframes and Engines •
Quail Decoy Missiles • Rotorcraft • Electronic Systems • Automation

MCDONNELL AIRCRAFT • ST. LOUIS